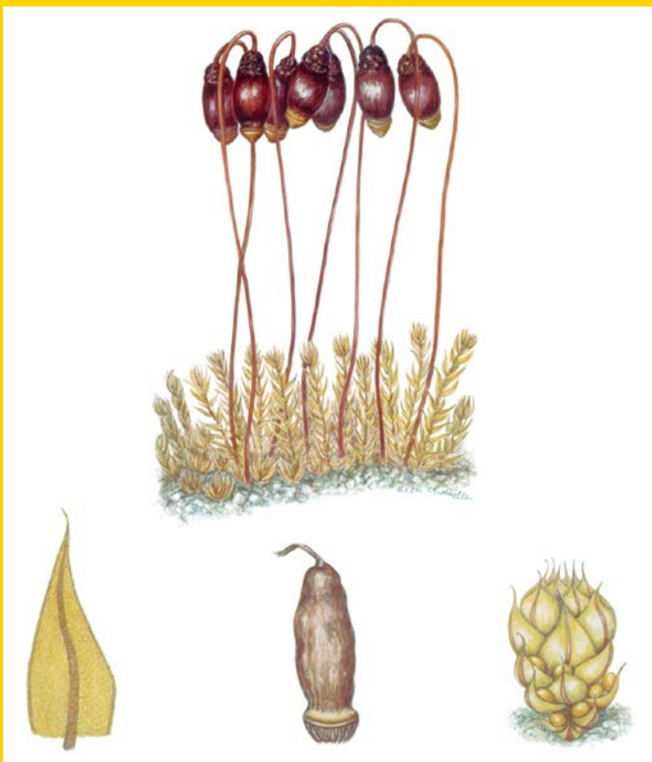
FLORA OF AUSTRALIA

Volume 51
Mosses 1



FLORA OF AUSTRALIA

This is the first of three volumes describing and illustrating more than 1,000 species of Australian mosses. Together, they will represent the first national account of these diverse and ecologically significant organisms. The main features of the first volume are:

An introduction documenting 200 years of research on Australian mosses; moss classification and an overview of morphology and sexuality; an account of ecology and biodiversity; the origin and evolution of mosses; fossil bryophytes; and a key to the more than 300 genera of mosses known from Australia and its island territories.

The volume includes traditional, *Flora of Australia*-style descriptions of 22 families, 42 genera and 238 species and infra-specific taxa, including synonymy, specimen citations and notes on habitat and distribution. Distribution maps are provided for each species and infra-specific taxon, as well as more than 50 pages of line-art illustrating habit and anatomy and 64 colour photographs.

Cover: *Gemmabryum pachythecum*.
Painting by Beth Chandler.

SYSTEMATIC ARRANGEMENT OF AUSTRALIAN MOSSES

Classification largely follows B.Goffinet & W.R.Buck, Systematics of the Bryophyta (mosses): from molecules to a revised classification, *Monogr. Syst. Bot.* 98: 205–239 (2004).

Class Sphagnopsida
Order Sphagnales
Family Sphagnaceae: *Sphagnum*
Order Ambuchananiales
Family Ambuchananiaceae: *Ambuchanania*

Class Andreaeopsida
Order Andreaeales
Family Andreaeaceae: *Andreaea*

Class Polytrichopsida
Order Polytrichales
Family Polytrichaceae: *Atrichum*, *Dawsonia*, *Notoligotrichum*, *Pogonatum*, *Polytrichadelphus*, *Polytrichastrum*, *Polytrichum*

Class Bryopsida
Subclass Buxbaumiidae
Order Buxbaumiales
Family Buxbaumiaceae: *Buxbaumia*

Subclass Diphysciidae
Order Diphysciales
Family Diphysciaceae: *Diphyscium*

Subclass Funariidae
Order Encalyptales
Family Encalyptaceae: *Encalypta*, *Bryobartramia*

Order Funariales
Family Funariaceae: *Entosthodon*, *Funaria*, *Physcomitrella*, *Physcomitrium*
Family Gigaspermaceae: *Gigaspermum*

Subclass Dicranidae
Order Scouleriales
Family Scouleriaceae: *Tridontium*

Order Grimmiales
Family Grimmiaceae: *Grimmia*, *Racomitrium*, *Schistidium*
Family Seligeriaceae: *Blindia*, *Brachydontium*, *Seligeria*
Family Ptychomitriaceae: *Ptychomitrium*

Order Archidiales
Family Archidiaceae: *Archidium*

Order Dicranales
Family Fissidentaceae: *Fissidens*, *Nanobryum*
Family Dicranaceae: *Campylopodium*, *Dicnemon*, *Dicranoloma*, *Dicranella*, *Dicranum*, *Eucamptodon*, *Holomitrium*, *Leptotrichella*, *Leucoloma*, *Sclerodontium*
Family Leucobryaceae: *Campylopus*, *Leucobryum*
Family Calymperaceae: *Arthrocormus*, *Calymperes*, *Exostratum*, *Leucophanes*, *Mitthyridium*, *Octoblepharum*, *Syrrhopodon*
Family Ditrichaceae: *Ceratodon*, *Chrysoblastella*, *Distichium*, *Ditrichum*, *Eccremidium*, *Garckea*, *Pleuridium*, *Wilsoniella*
Family Bruchiaceae: *Bruchia*, *Trematodon*
Family Rhabdoweisiaceae: *Amphidium*, *Dicranoweisia*, *Kiaeria*, *Verrucidens*
Family Erpodiaceae: *Erpodium*
Family Mitteniaceae: *Mittenia*
Family Viridivelleraceae: *Viridivellus*

Order Pottiales
Family Pottiaceae: *Acaulon*, *Aloinia*, *Anoectangium*, *Barbula*, *Bryoerythrophyllum*, *Calymperastrum*, *Calyptopogon*, *Chenia*, *Crossidium*, *Didymodon*, *Goniomitrium*, *Gymnostomum*, *Hennediella*, *Hymenostomum*, *Hyophila*, *Leptodontium*, *Microbryum*, *Phascopsis*, *Phascum*, *Pottia*, *Pseudosymblepharis*, *Pterygoneurum*, *Stonea*, *Tetrapterum*, *Tortella*, *Tortula*, *Trachycarpidium*, *Trichostomum*, *Triquetrella*, *Uleobryum*, *Weissia*
Family Pleurophascaceae: *Pleurophascum*
Family Splachnobryaceae: *Gymnostomiella*, *Splachnobryum*
Family Ephemeraceae: *Ephemerum*, *Nanomitriopsis*

Subclass Bryidae
Order Splachnales
Family Splachnaceae: *Tayloria*
Family Meesiaceae: *Leptobryum*, *Meesia*

Order Orthotrichales
Family Orthotrichaceae: *Groutiella*, *Macrocoma*, *Macromitrium*, *Orthotrichum*, *Schlotheimia*, *Stoneobryum*, *Ulota*, *Zygodon*

Order Hedwigiales
- Family Hedwigiaceae: *Hedwigia*, *Hedwigidium*
- Family Rhacocarpaceae: *Rhacocarpus*

Order Bryales
- Family Aulacomniaceae: *Aulacomnium*
- Family Bartramiaceae: *Bartramia*, *Breutelia*, *Conostomum*, *Philonotis*
- Family Orthodontiaceae: *Orthodontium*
- Family Bryaceae: *Brachymenium*, *Bryum*, *Gemmabryum*, *Ochiobryum*, *Plagiobryum*, *Ptychostomum*, *Rhodobryum*, *Rosulabryum*
- Family Mniaceae: *Mielichhoferia*, *Orthomnion*, *Plagiomnium*, *Pohlia*, *Schizymenium*
- Family *Leptostomaceae: Leptostomum*

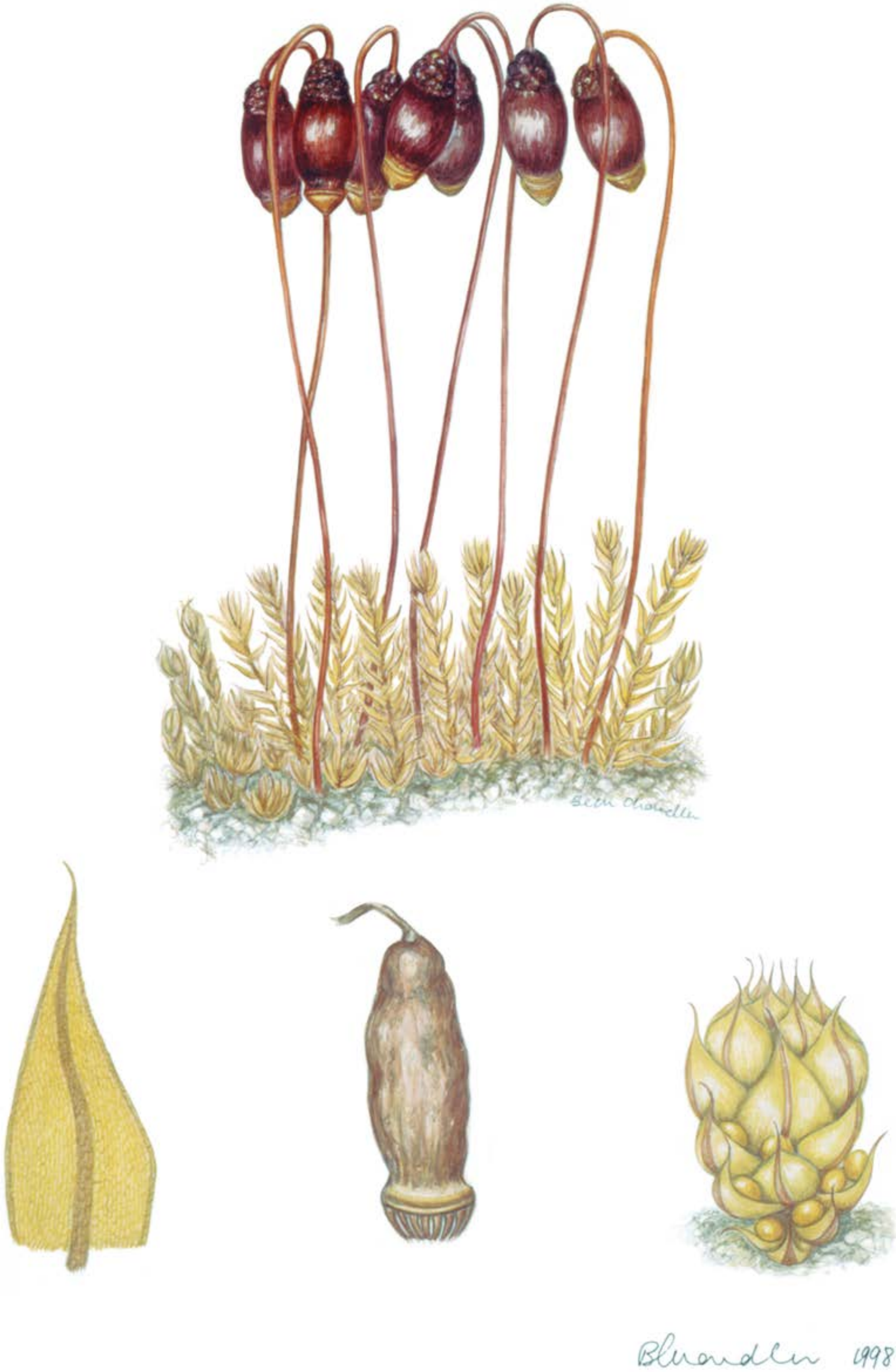
Order Rhizogoniales
- Family Hypnodendraceae: *Hypnodendron*
- Family Rhizogoniaceae: *Goniobryum*, *Hymenodon*, *Leptotheca*, *Mesochaete*, *Pyrrhobryum*, *Rhizogonium*
- Family Calomniaceae: *Calomnion*
- Family Cyrtopodaceae: *Bescherellia*
- Family Spiridentaceae: *Spiridens*
- Family Pterobryellaceae: *Pterobryella*
- Family Racopilaceae: *Powellia*, *Racopilum*

Order Ptychomniales
- Family Ptychomniaceae: *Euptychium*, *Garovaglia*, *Glyphothecium*, *Hampeella*, *Ptychomnion*, *Tetraphidopsis*

Order Hookeriales
- Family Hypopterygiaceae: *Cyathophorum*, *Hypopterygium*, *Lopidium*
- Family Saulomataceae: *Sauloma*
- Family Daltoniaceae: *Achrophyllum*, *Bryobrothera*, *Calyptrochaeta*, *Daltonia*, *Distichophyllum*, *Ephemeropsis*
- Family Leucomiaceae: *Leucomium*
- Family Pilotrichaceae: *Callicostella*, *Cyclodictyon*, *Hookeriopsis*

Order Hypnales
- Family Trachylomataceae: *Braithwaitea*, *Trachyloma*
- Family Climaciaceae: *Climacium*
- Family Amblystegiaceae: *Amblystegium*, *Anacamptodon*, *Bryostreimannia*, *Campylium*, *Cratoneuropsis*, *Drepanocladus*, *Leptodictyum*, *Orthotheciella*, *Sanionia*
- Family Calliergonaceae: *Scorpidium*, *Straminergon*, *Warnstorfia*
- Family Hylocomiaceae: *Rhytidiadelphus*
- Family Leskeaceae: *Claopodium*, *Pseudoleskeopsis*
- Family Catagoniaceae: *Catagonium*
- Family Pterigynandraceae: *Trachyphyllum*
- Family Thuidiaceae: *Pelekium*, *Thuidiopsis*, *Thuidium*
- Family Brachytheciaceae: *Brachythecium*, *Eurhynchium*, *Helicodontium*, *Platyhypnidium*, *Pseudoscleropodium*, *Rhynchostegium*, *Scleropodium*, *Scorpiurium*
- Family Stereophyllaceae: *Stereophyllum*
- Family Myriniaceae: *Macgregorella*
- Family Fabroniaceae: *Fabronia*, *Ischyrodon*
- Family Meteoriaceae: *Aerobryopsis*, *Barbella*, *Barbellopsis*, *Floribundaria*, *Meteoriopsis*, *Meteorium*, *Papillaria*, *Pseudospiridentopsis*, *Trachypus*
- Family Plagiotheciaceae: *Plagiothecium*
- Family Entodontaceae: *Entodon*, *Mesonodon*
- Family Hypnaceae: *Calliergonella*, *Ctenidium*, *Ectropothecium*, *Glossadelphus*, *Hypnum*, *Taxiphyllum*, *Vesicularia*
- Family Symphyodontaceae: *Chaetomitrium*, *Trachythecium*
- Family Pylaisiadelphaceae: *Clastobryum*, *Isocladiella*, *Isopterygium*, *Taxithelium*, *Trismegistia*, *Wijkia*
- Family Sematophyllaceae: *Acanthorrhynchium*, *Acroporium*, *Macrohymenium*, *Meiotheciella*, *Meiothecium*, *Papillidiopsis*, *Pseudohypnella*, *Radulina*, *Rhaphidorrhynchium*, *Sematophyllum*, *Trichosteleum*, *Warburgiella*
- Family Myuriaceae: *Myurium*, *Oedicladium*
- Family Cryphaeaceae: *Cryphaea*, *Cyptodon*, *Dendrocryphaea*, *Schoenobryum*
- Family Pterobryaceae: *Calyptothecium*, *Cryptogonium*, *Muellerobryum*, *Neolindbergia*, *Pterobryidium*, *Pterobryon*, *Pulchrinodus*, *Rhabdodontium*
- Family Orthorrhynchiaceae: *Orthorrhynchium*
- Family Lepyrodontaceae: *Lepyrodon*
- Family Neckeraceae: *Caduciella*, *Himantocladium*, *Homaliodendron*, *Neckera*, *Neckeropsis*, *Pinnatella*, *Thamnobryum*, *Touwia*
- Family Echinodiaceae: *Echinodium*
- Family Leptodontaceae: *Forsstroemia*, *Leptodon*
- Family Lembophyllaceae: *Acrocladium*, *Camptochaete*, *Fallaciella*, *Lembophyllum*, *Weymouthia*
- Family Anomodontaceae: *Anomodon*, *Herpetineuron*
- Family Sorapillaceae: *Sorapilla*

FLORA OF AUSTRALIA



Gemmabryum pachythecum (Müll.Hal.) J.R.Spence & H.P.Ramsay.
Painting by B.Chandler.

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FLORA OF AUSTRALIA

Volume 51
Mosses 1

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INTRODUCTION

This is the first of three volumes of the *Flora of Australia* which will document the more than 1000 species of moss. Volume 51 includes an introduction to Australian bryology, the biology of mosses, an account of fossil bryophytes, a key to the almost 300 moss genera known from Australia and its island territories, and taxonomic treatments of 22 families, 42 genera and 238 species and infraspecific taxa.

Scope and Presentation of the *Flora*

The geographical area covered by the *Flora* includes the six Australian States, the Northern Territory and the Australian Capital Territory.

Descriptions and discussion in the *Flora* are concise and supplemented by important references, synonymy, and information on type collections, distribution, habitat and published illustrations. Descriptions are based on Australian material except where that available to the contributor is inadequate, in which case extra-Australian collections or published descriptions have been used. Synonymy is restricted to names based on Australian types or those used in Australian literature. Misapplied names are given in square brackets together with an example of the misapplication.

Maps showing the distribution in Australia are arranged in the same sequence as the descriptions and are grouped together at the end of the main text. After each species or infra-specific taxon, up to eight collections are cited.

Type citations under taxa in the main body of the text reflect the authors' belief in their current status (holotype, isotype, syntype, etc) and where they are held. In cases where the type specimen has not been examined, this is indicated by *n.v.* These type statements are not to be interpreted as lectotypifications. Where lectotypifications have been made previously, these are cited with *fide*, followed by a reference to the author and place of publication (or, sometimes, to a secondary reference). Any formal lectotypifications required for this volume, as in previous parts of the *Flora*, are confined to the Appendix.

New taxa, combinations, lectotypifications, etc. are given in the Appendix where they are formally published in accordance with the *International Code of Botanical Nomenclature (Saint Louis Code)* (Koeltz Scientific Books, Königstein, 2000). A glossary of technical terms is included, as well as abbreviations, contractions and notes on format.

Acknowledgments

Twenty-four authors, illustrators and photographers have contributed to Volume 51. Their cooperation and that of the referees, usually working to tight deadlines, is gratefully acknowledged.

The production of this volume would not have been possible without the substantial assistance of the Australian herbaria. Their willingness to provide staff time and resources for this project of national importance is an outstanding example of co-operation between the States and the Commonwealth. Overseas institutions have also assisted preparation of the Volume with loans of specimens and by making facilities available to contributors and illustrators.

The Librarians at the Australian National Botanic Gardens were ever cheerful in assisting to locate references.

The Director, ABRS, acknowledges with great pleasure the input by staff of the Australian Biological Resources Study whose work, invisible in the final product, is essential in maintaining the high standards that this series has achieved.

The co-operation of CSIRO Publishing in bringing this book to press is gratefully acknowledged.

Bernard Goffinet's treatments of Splachnaceae and Splachnobryaceae were made possible through financial support from Duke University and NSF grant DEB 0089633.

Editor's Note

The Moss Flora of Macquarie Island by R.D.Seppelt (Australian Antarctic Division, Kingston, 2004) included part of a draft version of B.M.Murray's *Flora of Australia* treatment of Andreaeaceae which has been modified significantly in the current volume.

Plate 1. *Sphagnum cristatum*.
Photograph — W.M.Malcolm.

Plate 2. *Andreaea mutabilis*.
Photograph — R.Oldfield.

Plate 3. *Dawsonia superba* var. *pulchra*.
Photograph — R.Oldfield.

Plate 4. *Dawsonia superba* var. *pulchra*.
Photograph — R.Oldfield.

Plate 5. *Pogonatum subulatum*.
Photograph — R.Oldfield.

Plate 6. *Notoligotrichum crispulum*.
Photograph — W.M.Malcolm.

Plate 7. *Pogonatum subulatum*.
Photograph — R.Oldfield.

Plate 8. *Polytrichadelphus magellanicus*.
Photograph — W.M.Malcolm.

Plate 9. *Polytrichadelphus magellanicus*.
Photograph — R.Oldfield.

Plate 10. *Polytrichum juniperinum*.
Photograph — H.Lepp.

Plate 11. *Gigaspermum repens*.
Photograph — R.Oldfield.

Plate 12. *Polytrichum juniperinum*.
Photograph — H.Lepp.

Plate 13. *Gigaspermum repens*.
Photograph — H.Lepp.

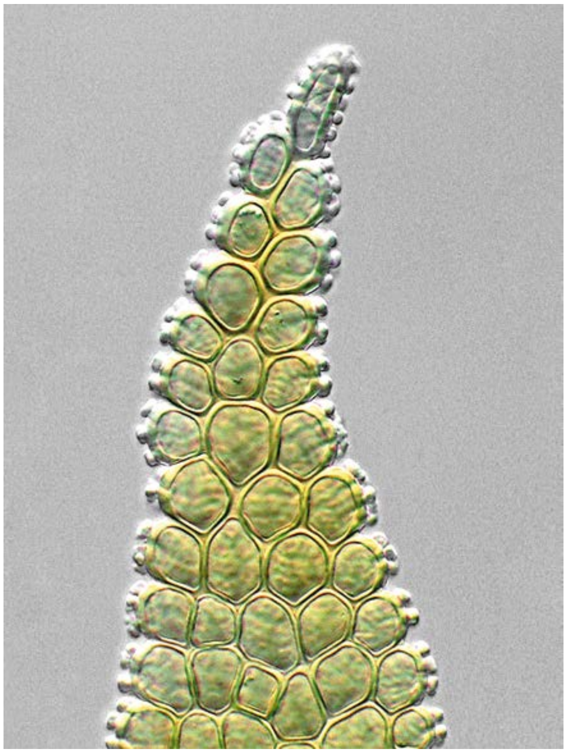

Plate 14. *Erpodium glaucum*.
Photograph — W.M.Malcolm.

Plate 15. *Tayloria gunnii*.
Photograph — H.Lepp.

Plate 16. *Erpodium hodgkinsoniae*.
Photograph — H.Lepp.

Plate 17. *Tayloria octoblepharum*.
Photograph — R.Oldfield.

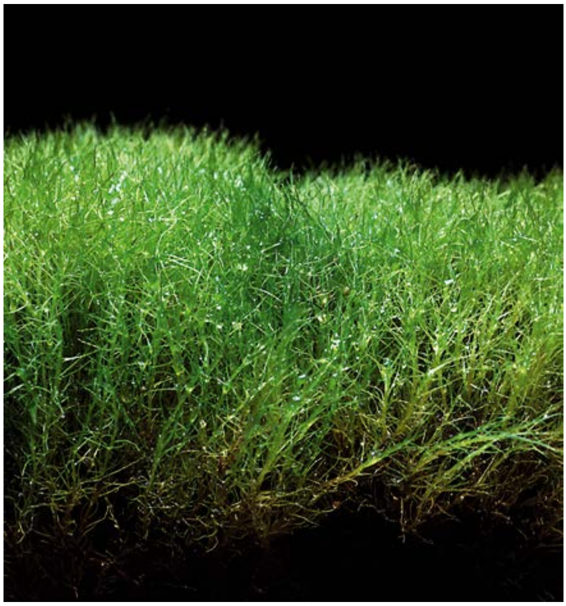

Plate 18. *Leptobryum pyriforme*.
Photograph — R.Oldfield.

Plate 19. *Macromitrium archeri*.
Photograph — R.Oldfield.

Plate 20. *Macromitrium archeri*.
Photograph — R.Oldfield.

Plate 21. *Macromitrium involutifolium* var. *ptychomitrioides*.
Photograph — H.Lepp.

Plate 22. *Orthotrichum assimile*.
Photograph — R.Oldfield.

Plate 23. *Orthotrichum cupulatum* var. *cupulatum*.
Photograph — R.Oldfield.

Plate 24. *Orthotrichum tasmanicum* var. *tasmanicum*.
Photograph — R.Oldfield.

Plate 25. *Ulota lutea* var. *lutea*.
Photograph — W.M.Malcolm.

Plate 26. *Bartramia robusta*.
Photograph — R.Oldfield.

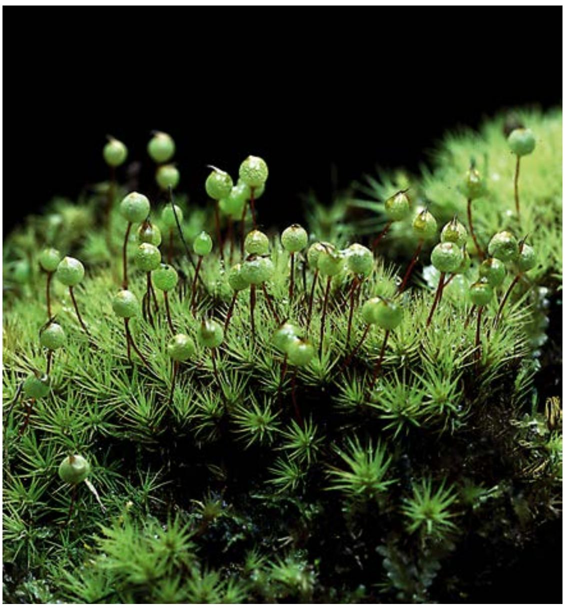

Plate 27. *Bartramia robusta*.
Photograph — R.Oldfield.

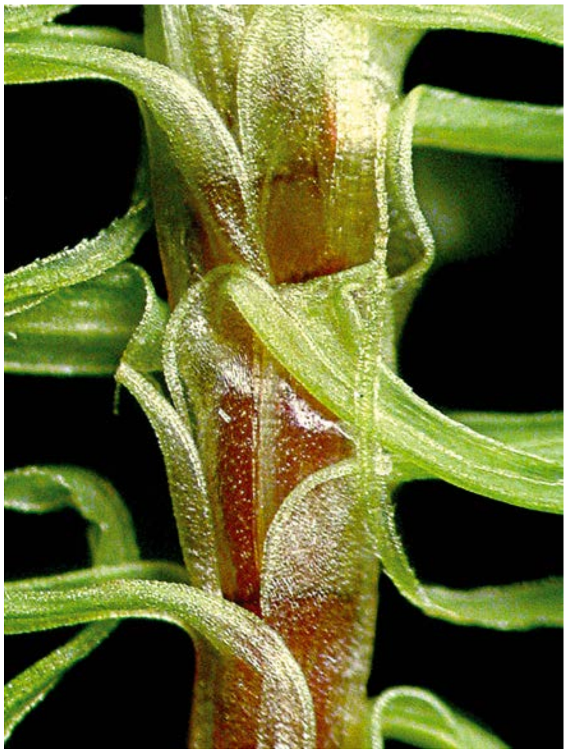

Plate 28. *Bartramia mossmanniana*.
Photograph — W.M.Malcolm.

Plate 29. *Breutelia pendula*.
Photograph — W.M.Malcolm.

Plate 30. *Breutelia pseudophilonotis*.
Photograph — R.Oldfield.

Plate 31. *Breutelia pseudophilonotis*.
Photograph — R.Oldfield.

Plate 32. *Conostomum pentastichum*.
Photograph — W.M.Malcolm

HISTORY OF RESEARCH ON AUSTRALIAN MOSSES

Helen P. Ramsay[1]

The botanical collections made by the European explorers and naturalists who visited Australia in the late eighteenth and early nineteenth centuries were usually deposited in museums or herbaria in their home countries to be studied by local specialists. Subsequently, the important contributions made by European botanists to the development of Australian bryology can be seen in the publications of G.E.L.Hampe (1795–1880), C.Müller (= J.K.A.Müller; 1818–1899), W.Mitten (1819–1906), A.Geheeb (1842–1899), V.F.Brotherus (1849–1929), H.N.Dixon (1861–1944) and others (Scott & Stone, 1976; Streimann & Curnow, 1989; Tan, 1992; Ramsay & Seur, 1994). Prior to the 1950s, the type specimens of most Australian mosses were held in herbaria in London (BM; Dixon), Helsinki (H-BR; Brotherus), New York (NY; Mitten) and Berlin (B; Müller). Unfortunately, most of Müller's specimens, including types, were lost when Naturhistorisches Museum Berlin-Dahlem was destroyed in a bombing raid on 1 March 1943. The loss of Müller's types and the inadequacy of many of his descriptions created nomenclatural problems for succeeding taxonomists. Fortunately, a few of his Australian holotypes and some isotypes were retained in the National Herbarium of Victoria and the National Herbarium of New South Wales (Ramsay *et al*., 1990; Ramsay & Seur, 1994).

It was not until the early years of the twentieth century that local botanists began to document and formally describe Australian mosses. These contributors to Australian bryology ranged from the professional botanist to the dedicated amateur or naturalist whose occupations included teacher, doctor, clergyman, pharmacist, dental surgeon, architect and farmer. Bryological studies in Australia, particularly those on mosses, can be divided into two main periods of activity: early (early 1800s to 1950) and recent (1950 to the present).

Early 1800s to 1950

The earliest collections of Australian mosses were made by J.-J.H. de Labillardière in south-western Australia and Tasmania during the D'Entrecasteaux expedition of 1791–1794 (Labillardière, 1807). Subsequently, the renowned botanist Robert Brown accompanied Matthew Flinders on the *Investigator* in 1801 and, during the next four years, he collected specimens from around the coast of Australia (Brown, 1811, 1814). Brown described a number of Australian moss species, including *Dawsonia polytrichoides* R.Br. and *Leptostomum inclinans* R.Br.

The immense size of Australia and its political division into six separate Colonies until 1901 resulted in a rather fragmented and parochial view of bryology in the 1800s. However, in spite of the difficulties of travel, collectors ventured great distances to obtain specimens. The importance of these local botanists and naturalists cannot be overstated. Field Naturalist Clubs (e.g. in Victoria and Queensland) played an critical role in encouraging amateurs to pursue their botanical interests as well as publishing many new records in their journals. The period from the mid-1800s to the early 1900s was highly productive, and much of the early knowledge of Australian mosses was derived from the efforts of a large number of contributors (see Maiden, 1908a, b, 1909, 1912, 1921).

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New South Wales

At the turn of the twentieth century, William Forsyth (1864–1910), The Reverend William W. Watts (1856–1920) and Thomas Whitelegge (1850–1927) were the leading bryologists in New South Wales. *Census Muscorum Australiensium* (Watts & Whitelegge, 1902, 1906) included data on Australian mosses, incorporating accepted names, synonyms, collectors and localities. However, these publications, although detailed, lacked information on the pleurocarpous species which was subsequently published by Alan Burges (1932, 1935).

William Forsyth came to Australia from Scotland, and became a horticulturist and an accomplished botanist. In 1886 he was appointed overseer for Centennial Park in Sydney, and in 1898 he took on the responsibility for collecting and maintaining mosses at the National Herbarium of New South Wales. Forsyth collected bryophytes in many parts of the State, including Mt Kosciuszko, the Blue Mountains, the South Coast, the North Coast and the Northern Tablelands, and he began an exchange program with overseas bryologists, primarily Brotherus in Helsinki. He published a list of 61 species, 43 of which were new State records (Forsyth, 1899).

In 1884–1885, Thomas Whitelegge began to accumulate information on the mosses of New South Wales. At the request of Brotherus, who was preparing a world moss flora (Brotherus, 1901–1909, 1924–1925), he collected diligently, particularly in the Central Coast and Tablelands. Whitelegge compiled a preliminary list of some 300 mosses from New South Wales which was never published.

William Watts was born in England, and travelled to Australia from Coventry after a breakdown in his health. He accepted a call to the Church in Brisbane in 1887 (Ramsay, 1980) and later moved to Ballina in northern New South Wales. He became a distinguished naturalist, and his collections (housed in NSW) include 12,000 mosses, several thousand hepatics, as well as ferns and lichens. His publications (see Ramsay, 1980) represent an impressive contribution to Australian botany. Watts' collections from New South Wales, Lord Howe Island, Queensland and Victoria are substantial, and duplicates have been distributed to many overseas herbaria. Watts met Whitelegge in 1898, and they prepared a list of 500 species for New South Wales. However, the manuscript was withdrawn from publication in favour of a broader list covering the whole of Australia (Watts & Whitelegge, 1902, 1906).

Watts exchanged specimens and corresponded with European authorities such as Cardot, Dixon and Stephani, but he relied primarily on Brotherus for the identification of his mosses (Koponen, 2005). The collaboration of Brotherus and Watts resulted in a important series of publications (Watts, 1899, 1900, 1905, 1906, 1912; Brotherus & Watts, 1912, 1915, 1918).

Queensland

Frederick M. Bailey (1827–1915), one of the most significant Queensland botanists, was born in London and migrated to South Australia in 1839. He moved to New Zealand in 1853, then to Brisbane in 1861. He travelled widely from 1875 investigating diseases of livestock and plants. In 1881 he was appointed Colonial Botanist in charge of the Queensland Museum. A list of mosses of Queensland was included in his *Catalogue of Queensland Plants* (Bailey, 1913) based on his own collections and those donated by others. About the same time, C.J.Wild, a Council member of the Natural Historical Society of Queensland, collected widely and published notes on Queensland mosses (Wild, 1888, 1889). He was Acting Director of the Queensland Museum from 1905 to 1910.

Hugo Flecker (1884–1957), a world-renowned radiologist based in Melbourne, moved his practice to Cairns in 1932. He had a broad interest in natural history, particularly tropical plants, and the Flecker Botanical Gardens in Cairns are named in his honour (Clarkson, 1990). A number of new moss species were described by Dixon (1938, 1941) based on Flecker's collections, many of which are now housed in the Australian National Herbarium in Canberra. Included in the Flecker herbarium were the Australian collections of Amalie Dietrich (1822–1891) who arrived in Australia from Germany in 1863. She collected for about ten years, mainly in Queensland, and then returned to Germany to work in the Museum Godeffroy and the Botanical Museum in Hamburg.

South Australia

The first list of South Australian mosses was compiled by Müller & Hampe (1853), based on collections made by Ferdinand von Mueller. Of the 84 species listed for Australia, 27 were recorded for South Australia, 10 being newly described. Ralph Tate (1840–1901) published a list of South Australian species (Tate, 1881, 1882) collected by Mueller and schoolmaster J.G.Otto Tepper (1841–1923).

Tasmania

An early account of Tasmanian mosses was provided by William M. Wilson (1799–1871) who described many novelties (Hooker & Wilson, 1844). During this period, William Archer (1820–1874) an architect and expert on orchids was one of the most significant bryophyte collectors. Later in the nineteenth century, Tasmania produced two the most accomplished bryologists in Australia, William A. Weymouth (1841–1928) and Leonard Rodway (1853–1936).

Weymouth pursued his interest in natural history through his liaison with European bryologists such as Brotherus, Burchard and Levier. He made extensive collections of mosses, duplicates of which are held in HO, BM, V and NAP, and he became an authority on the Tasmanian species (Weymouth, 1894, 1896, 1903; Weymouth & Rodway, 1922).

Born in England, Rodway came to Tasmania as a dental surgeon in 1880. He was appointed Honorary Government Botanist in Hobart in 1896, a position he held until 1932. He also lectured on botany at the University of Tasmania (1923–1929) and was a Trustee of the Tasmanian Museum and Botanical Garden (1928–1932). Rodway’s herbarium (in HO) contains many important specimens which were later documented by Sainsbury (1953a, b). Rodway’s moss flora, published as separate papers (Rodway, 1913, 1914a), was reissued as a single volume (Rodway, 1914b) followed by supplements (Rodway, 1915, 1916).

Richard A. Bastow (1840–1920), an architectural draftsman with a flair for cryptogamic botany, had an interest in the bryophytes of both Tasmania and Victoria. He compiled a list of Tasmanian mosses which included an illustrated key (Bastow, 1887). He also prepared notes on collecting, preserving and describing mosses (Bastow, 1892) and was the author of several other bryological publications (Bastow, 1886a, b, c, 1887, 1905).

Victoria

The great pioneer of botanical research in Victoria, indeed in Australia, was Ferdinand J.H. von Mueller (1825–1896) (Willis, 1949, 1989). He arrived in South Australia from Germany in 1847, moving to Melbourne in 1852 where, in 1853, he was appointed the first Government Botanist of Victoria, a position he held until his death. From 1857 to 1873 Mueller was also Director of Melbourne Botanical Gardens. He was an avid collector, and between 1847 and 1877 travelled at least 23,000 km often on foot or on horseback in the alpine regions of Australia (Gillbank, 1992). During the first three years of his appointment he collected 800 cryptogams. Specimens were sent to England for identification and description by William Mitten (Mitten, 1859, 1860, 1882; Mueller, 1864).

Others were engaged in bryological studies in Victoria during the second half of the nineteenth century. Daniel Sullivan (1836–1895), a school headmaster, systematically collected mosses around the Grampians during 1870–1880. He sent specimens to Müller in Berlin for identification and published a list of the mosses of Victoria (Sullivan, 1887). Significant collections were made in the Australian Alps by James Stirling (1852–1905) (Stirling, 1886), while Felix M. Reader (1850–1911), a pharmacist in Dimboola in the 1890s to early 1900s, collected many specimens that were identified by Brotherus (Reader, 1898a, b).

Western Australia

Some of the earliest reports of Australian (“New Holland”) bryophytes came from Western Australia, specifically from the Swan River Colony, i.e. various settlements in the south-west of the State, including King George Sound near Albany (Hooker, 1840, 1845; Hampe, 1844;

Taylor, 1846). Important collectors included James Drummond (1784–1862) and Johann August Ludwig Preiss (1811–1883) (McGillivray, 1975; Marchant, 1990).

Drummond, an agriculturist, arrived at Perth in 1829 as Government Naturalist, and between 1831 and 1834 he was in charge of the Colony's first Government Garden. During 1835–1852 he made extensive journeys, as far as King George Sound in the south-west and the Moore and Murchison Rivers in the north. Preiss, a naturalist, came to Fremantle from Germany in 1838 and accumulated a fine botanical collection, including bryophytes. He and Drummond frequently conferred and sometimes travelled together on field excursions (McGillivray, 1975). Interest in the western bryoflora dissipated shortly afterwards and has only been revived in comparatively recent times.

Recent Research

Following the death of Watts and until the end of the Second World War, bryological activity all but ceased in Australia. Alan Burges (later Professor of Botany at the University of Sydney, 1948–1954), completed the work of Watts and Whitelegge by updating and publishing their manuscript on pleurocarpous mosses (Burges, 1932, 1935). Burges also prepared, but did not publish, a list of mosses of New South Wales that formed the basis for the census published by his student Helen P. Ramsay (1984a).

During the 1950s, James H. Willis (1910–1995) was at the forefront of bryology in Australia. Willis began as an Herbarium Assistant (1939–1961) and later became Assistant Government Botanist (1961–1970) and Acting Director of the Royal Botanic Gardens Melbourne and the National Herbarium of Victoria (1970–1972). He prompted a resurgence of interest in Australian bryology with a series of papers, mainly in the *Victorian Naturalist*, during 1950–1958. He also contributed greatly to the understanding of mosses in Western Australia and the Northern Territory, and he deposited many significant specimens in MEL (Anon., 1975). Another Victorian, Trevor Clifford (later Professor of Botany at the University of Queensland) also took an interest in mosses at this time (Clifford & Willis, 1951, 1952; Clifford, 1952).

Willis often sought advice from George O.K. Sainsbury who was studying the mosses of New Zealand and whose contributions to bryology in New Zealand (Sainsbury 1955) and Australia (Sainsbury, 1932a–d, 1947, 1948, 1953a, b, 1956) are of great significance. A contemporary, Edwin B. Bartram, described mosses from the Pacific region (especially Hawai'i and the Philippines) as well as Western Australia and Queensland (Bartram, 1951, 1952).

George A.M. Scott, Ilma G. Stone, David G. Catcheside, Heinar Streimann, Rodney D. Seppelt and Helen P. Ramsay have been leading lights in Australian bryology since the 1970s. *The Mosses of Southern Australia* (Scott & Stone, 1976), superbly illustrated by Celia Rosser, increased local interest and provided a better understanding of temperate Australian mosses. Before its publication, the identification of Australian specimens required reference to Brotherus' *Natürlichen Pflanzenfamilien* (1901–1909, 1924–1925) or Sainsbury's *Handbook of New Zealand Mosses* (1955), neither of which provided keys to the families or genera. However, Sainsbury's volume was and still is useful for temperate species, but it is of very limited use for the identification of the tropical and subtropical mosses of northern Australia. Scott & Stone (1976) not only provided descriptions of the temperate species, they also listed tropical Australian mosses and provided information on distribution and a comprehensive bibliography.

The contribution of George A.M. Scott (1933–1998) to Australian bryology has been exceptional, particularly with regard to ecology and taxonomy (Scott, 1982a, b, c; 1988). In 1979 he initiated a five-day identification course at Monash University in Melbourne, which brought together field naturalists and laboratory-based professionals, beginners and experts, the young and the old to learn about the cryptogamic flora and the need for its conservation. These courses ran until 1985 and were the precursors of bryological workshops now held biennially. Scott was a respected member of the international bryological

community and served as a council member of the International Bryological Society for two terms. He trained a number of students who are now pursuing careers in bryology. In his later years, Scott concentrated on the study of hepatics (Scott, 1985; Scott & Bradshaw, 1986; Scott & Pike, 1987a, b, c, 1988a, b, c).

The collecting and research activities of Ilma G. Stone (1913–2001), particularly those involving tropical Queensland mosses and her work on minute, arid-zone species, have been outstanding in terms of their volume and quality. Her extensive list of publications includes revisions of families such as Calymperaceae (Reese & Stone, 1987, 1995), Fissidentaceae (Stone, 1983a, b, 1984, 1986b, 1987, 1988, 1989a, 1990a, b, 1991, 1994a, b; Stone & Catcheside, 1993; Stone & Beever, 1996) and Ephemeraceae (Stone, 1996), revisions of *Phascum* and *Acaulon* (Stone, 1989b), many new Australian records, new species and the genera *Calymperastrum* (Stone, 1986a) and *Viridivellus* in the newly described family Viridivelleraceae (Stone, 1976). Her thousands of collections have recently been transferred from MELU to MEL where they are now databased.

The late David G. Catcheside's (1907–1994) broad knowledge of mosses can be traced back to his early years in England and contact with British bryologists such as H.N.Dixon (Richards, 1995). His best-known publication, *Mosses of South Australia* (Catcheside, 1980), included keys, descriptions and illustrations for all known species as well as new information on many semi-arid Australian mosses. Later work included revisionary studies on *Bartramia* (Catcheside, 1987) and *Campylopus* (Catcheside & Frahm, 1985). At the time of his death, he was preparing treatments of Pottiaceae, Dicranaceae and other smaller families for the *Flora of Australia*. Catcheside's herbarium of almost 9,000 specimens is held in the State Herbarium of South Australia (AD).

Scott, Stone and Catcheside, through their knowledge and enthusiasm, were instrumental in stimulating an active interest in Australian bryophytes, encouraging activities at all levels from preparing local lists or recording new species locations to writing taxonomic revisions. In the field, they patiently helped others with identification and provided hints on how to find and recognise difficult species.

Heinar Streimann (1938–2001) travelled and collected extensively in Australia, Papua New Guinea and the Pacific, and his specimens dominate what is now the largest bryophyte collection in Australia located in the Australian National Herbarium, Canberra (CANB). He distributed duplicates on exchange to overseas herbaria and issued 18 fascicles of *Musci Australasiae Exsiccati* (1992–2000). The species lists and bibliography of his *Catalogue of Mosses of Australia and its External Territories* (Streimann & Curnow, 1989) and the posthumous *Catalogue of Australian Mosses* (Streimann & Klazenga, 2002) have been of considerable help to other bryologists. Among his other achievements are revisions of the Australian Meteoriaceae (Streimann, 1991a, b, 1993) and Hookeriaceae (Streimann, 1997, 1999, 2000, 2001) and an illustrated moss flora of Norfolk Island (Streimann, 2002).

Rodney D. Seppelt, a student of Ilma Stone, has studied and published on mosses, hepatics and lichens. While the early part of his career concentrated on the Australian Ditrichaceae (Seppelt & Stone, 1977; Seppelt, 1980a, b, c, 1982a, b, c, 1990, 1996), he has also made significant contributions to our understanding of the Sphagnopsida (Yamaguchi *et al.*, 1990, 1992; Seppelt & Crum, 1999; Seppelt, 2000). Furthermore, he has investigated the taxonomy, biology and biodiversity of the mosses of the Subantarctic Macquarie and Heard Islands as well as Antarctica and has made more than 35 visits to those remote regions. Most recently, he has completed a richly illustrated moss flora of Macquarie Island (Seppelt, 2004).

The research activities of Helen P. Ramsay have included cytological, cytotaxonomic, taxonomic and biosystematic studies on genera including *Dawsonia* (Ramsay, 1964) and *Dicranoloma* (Ramsay, 1985), and families such as Hypnodendraceae (Ramsay, 1987), Orthotrichaceae (Ramsay & Lewinsky, 1984; Vitt & Ramsay, 1985a, b; Ramsay & Vitt, 1986), Sematophyllaceae (Tan *et al.*, 1996, Ramsay *et al.*, 2002a, b, 2004), Bryaceae (Ramsay & Spence, 1996; Spence & Ramsay, 1996a, b, 2002, 2005) and Polytrichaceae (Ramsay, 1997). She is especially noted for her studies of the chromosomes of Australian and other mosses which began in 1964. Moreover, she has catalogued the type specimens of mosses in Australian herbaria (Ramsay & Seur, 1990, 1994; Ramsay *et al.*, 1990) and, most

recently, has provided the first comprehensive overview of mosses in the wet tropics of north-eastern Queensland (Ramsay & Cairns, 2004). She initiated, with Patricia Selkirk, the *Australasian Bryological Newsletter* and edited that publication for 12 years.

Stimulated by earlier bryologists, a new generation of researchers is working in many parts of Australia and contributing in various ways to our knowledge of Australian mosses.

Niels Klazenga, working at the National Herbarium of Victoria, was trained at Leiden University and Herbarium and has brought to Australia his expertise in traditional and modern moss taxonomy. He made an invaluable contribution to the completion of *Catalogue of Australian Mosses* (Streimann & Klazenga, 2002) and published a revision of the genus *Dicranoloma* (Klazenga, 2003) and an overview of generic concepts in Australian mosses (Klazenga, 2005).

David Meagher (University of Melbourne) wrote *A Field Guide to Mosses and Allied Plants of Southern Australia* with the photographer Bruce Fuhrer (Meagher & Fuhrer, 2003). Although his main interest in is liverworts, he has also published on mosses (e.g. Meagher, 1996, 1999; Meagher & Scott, 1998).

Patricia M. Selkirk has made 17 visits to Antarctica and the Subantarctic islands. Her research has focused on landscape-level geomorphology and vegetation history as well as plant reproduction, pioneering the study of subcellular genetics of Antarctic bryophytes (e.g. Selkirk, 1984; Selkirk *et al.*, 1997, 1998) and compiling an overview of the biota of Macquarie Island (Selkirk *et al.*, 1990).

A former student of Selkirk's, Dana M. Bergstrom (Australian Antarctic Division) has published on the mosses of Heard and Macquarie Islands (Bergstrom & Selkirk, 1987, 1997, 1998; Bergstrom & Seppelt, 1988), while another former student, Mary L. Skotnicki (Australian National University), has studied genetic diversity in Antarctic mosses (e.g. Skotnicki *et al.*, 1998a, b, 2000, 2004).

In 2004 Alison Downing was honoured with the naming of the Herbarium at Macquarie University, New South Wales "The Downing Herbarium". This was in recognition of her efforts in setting up and maintaining that facility over a period of more than 30 years. Downing's collections and publications on calcicolous mosses have been significant (e.g. Downing, 1992; Downing *et al.*, 1991, 1997; Downing & Selkirk, 1993). Ron Oldfield, is a colleague of Downing's and has collaborated with her in several studies (e.g. Downing & Oldfield, 2000; Downing *et al.*, 1995, 2002).

Andi Cairns (James Cook University, Townsville) is helping to promote interest in tropical mosses. A recent paper (Ramsay & Cairns, 2004) is intended to be the first of a series of publications documenting the distribution of bryophytes in the Wet Tropics bioregion.

Patrick J. Dalton (University of Tasmania, Hobart) has edited and improved the *Australasian Bryological Newsletter* since 1991. He has also published several papers on Tasmanian mosses (Dalton 1995, 1998; Dalton *et al.*, 1991, 1999).

Other Australian workers have recently undertaken floristic, ecological or taxonomic research on bryophytes. They include Graham Bell (AD; Pottiaceae), Karen Beckmann (MEL; liverworts), Alan Bolin (BRI; bryophytes), Elizabeth Brown and colleagues (NSW; liverworts), Christine Cargill, Judith Curnow and Heino Lepp (CANB; liverworts & hornworts), Robert Coveny (NSW; bryophytes), David Eldridge and co-workers (University of New South Wales; bryophytes), Scott Gilmore (Australian National University; mosses), Jean Jarman (HO; bryophytes), Josephine Milne (MEL; mosses), Sharon Morley (Deakin University; bryophytes), Emma Pharo (University of Tasmania; bryophytes), David Ratkowsky (Hobart; bryophytes), Arthur Thies (MEL; mosses) and Perpetua Turner (Australian Antarctic Division; mosses).

Checklists of mosses have been published for all Australian States and mainland Territories: South Australia (Catcheside, 1980); New South Wales (Ramsay, 1984a); the Australian Capital Territory (Ramsay & Streimann, 1984); the Northern Territory (Catcheside & Stone, 1988); Queensland (Bolin, 2002); Victoria (Cropper *et al.*, 1991); Tasmania (Dalton *et al.*, 1991); and Western Australia (Stoneburner *et al.*, 1993). Streimann & Klazenga (2002)

provided a catalogue of Australian mosses, with distribution by State and Territory, which updated the earlier checklist of Streimann & Curnow (1989).

In addition to the works cited above, lists of bryophytes have also appeared in print, often as part of broader floristic or ecological studies (e.g. Ratkowsky & Ratkowsky, 1982; Kantvilas & Jarman, 1991, 1993; Moscal & Kirkpatrick, 1992, 1995; Ratkowsky *et al.*, 1993; Jarman & Kantvilas, 1994, 2001; Pharo & Beatty, 1997, 2002; Pharo & Blanks, 2000; Whinan & Chilcott, 2002).

In recent years, the availability of well-illustrated field guides to mosses has facilitated a greater appreciation of their diversity and distribution in Australia and its territories. These publications include *Mosses and Liverworts of Rainforest in Tasmania and South-eastern Australia* (Jarman & Fuhrer, 1995), *Key to the Genera of Australian Mosses* (Buck *et al.*, 2002), *The Mosses of Norfolk Island* (Streimann, 2002), *A Field Guide to the Mosses and Allied Plants of Southern Australia* (Meagher & Fuhrer, 2003) and *The Moss Flora of Macquarie Island* (Seppelt, 2004).

Australasian Bryological Workshops are held regularly to exchange ideas, investigate different habitats, seek new records or species and to encourage younger bryologists. Workshops have taken place in Hobart (1988), Canberra (1991), Kuranda, north Queensland (1994), south-eastern Queensland (1996), Grampians, Victoria (1998), Blue Mountains, New South Wales (2000), Melbourne and Mt Baw Baw, Victoria (2002) and Townsville (2005).

Our understanding of Australian mosses continues to benefit from the support of the wider bryological community. Many foreign bryologists have visited Australia or have studied large numbers of Australian specimens. The following have been among the most notable contributors: Hisatsugu Ando, Jessica Beever, Bill Buck, Steven Churchill, Johannes Enroth, Allan Fife, Jan-Peter Frahm, Bernard Goffinet, Henk Greven, Jette Lewinsky-Haapasaari, Lars Hedenäs, Diana Horton, Jaakko Hyvönen, Zen Iwatsuki, Timo Koponen, Hans Kruijer, Barbara Murray, Angela Newton, Dan Norris, Harumi Ochi, Ryszard Ochyra, Bill Reese, Noris Salazar Allen, Wilf Schofield, Jon Shaw, Philip Sollman, John Spence, Ann Stoneburner, Benito Tan, Ray Tangney, Andries Touw, Dale Vitt, Robert Wyatt, Tomio Yamaguchi and Ben van Zanten.

Since 1970, taxonomic investigations have resulted in revisions of moss families such as Andreaeaceae (Murray, 1988), Brachytheciaceae (Hedenäs, 1996, 2002), Bryaceae (Ochi, 1970, 1973; Spence 1996; Spence & Ramsay, 1996a, b, 1999, 2002), Calymperaceae (Reese 1987, 1989; Reese & Stone, 1987, 1995; Reese *et al.*, 1991), Ephemeraceae (Stone, 1996), Funariaceae (Fife & Seppelt, 2001), Hookeriaceae (Streimann, 1997, 1999, 2000, 2001), Hypnodendraceae (Touw, 1971), Hypopterygiaceae (Kruijer, 2002), Lembophyllaceae (Tangney, 1997a, b), Leptostomaceae (Hyvönen, 1987; Crum, 1992), Meteoriaceae (Streimann, 1991a, b), Sematophyllaceae (Tan *et al.*, 1996; Ramsay *et al.*, 2002a, b, 2004), Sphagnaceae (Seppelt, 2000) and Thuidiaceae (Touw & Falter-van den Haak, 1990; Touw, 2001a, b).

Recent generic revisions emphasising or providing significant information on the Australian moss flora include those of *Dawsonia* (van Zanten, 1973), *Ditrichum* (Seppelt, 1980a, b, c; 1982a, b; Seppelt & Stone, 1977), *Hypnum* (Ando, 1982), *Orthotrichum* (Lewinsky, 1984), *Zygodon* (Lewinsky, 1990), *Macromitrium* (Vitt & Ramsay, 1985a, b), *Schlotheimia* (Vitt, 1989), *Stoneobryum* (Norris & Robinson, 1981), *Touwia* and *Bryostreimannia* (Ochi, 1986, 1990, 1991), *Bartramia* (Catcheside, 1987), *Campylopus* (Catcheside & Frahm, 1985; Frahm, 1987, 1988, 1990, 1994), *Fissidens* (Bruggeman-Nannenga, 1979, 1997; Stone, 1983a, b, 1984, 1986b, 1987, 1988a, 1989a, 1990a, b, 1991, 1994a, b; Stone & Catcheside, 1993; Bruggeman-Nannenga *et al.*, 1994; Bruggemann-Nannenga & Pursell, 1995; Stone & Beever, 1996), *Campylopus* (Frahm, 1987, 1994), *Acaulon* and *Phascum* (Stone, 1989b), *Pogonatum* (Hyvönen, 1989), *Entodon* (Buck, 1990), *Plagiothecium* (Ireland, 1992), *Leucobryum* (Yamaguchi, 1993), *Leucophanes* (Salazar Allen, 1993), *Pinnatella* (Enroth, 1994), *Cyptodon* (Enroth, 1995), *Cryphaea* (Enroth, 1996), *Lepyrodon* (Allen, 1999), *Grimmia* (Greven, 2000) and *Dicranoloma* (Klazenga, 2003).

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INTRODUCTION TO MOSSES

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Classification

Before the late-eighteenth century, the nature of bryophytes and their relationships to the rest of the Plant Kingdom were poorly understood. Although Carl Linnaeus (1707–1778) described eight genera of mosses (Linnaeus, 1753), only *Sphagnum* survives in modern bryophyte systematics. Johann Hedwig (1730–1799) interpreted the functions of antheridia, archegonia and the sporophyte, including the peristome, and his use of microscopic as well as macroscopic characteristics greatly influenced subsequent bryophyte systematics and taxonomy. Hedwig provided a well-illustrated and essentially complete and accurate account of the bryophyte life history (see Schofield, 1985), and his *Fundamentum* (Hedwig, 1782) included descriptions and illustrations of many taxa. Using three characters — the presence or absence of peristome, the form of the male inflorescence, and the form of peristome — Hedwig distinguished 25 moss genera, later expanded to 35, this work being published posthumously as *Species Muscorum Frondosorum* (Hedwig, 1801). Hedwig's herbarium was later acquired by Christian Friedrich Schwägrichen (1775–1853) who published many additional moss names (Schwägrichen, 1811–1842). Margadant (1968) has provided a detailed review of early theories of sexuality in bryophytes and bryophyte relationships.

The concept of alternation of gametophytic and sporophytic generations was first clearly documented by Wilhelm Hofmeister (1851). Wilhelm Schimper (1808–1880) contributed to an understanding of European bryology, including a significant advance in interpreting the taxonomy of *Sphagnum* (Schimper, 1856). During this period, Johann Karl (Carl) August Müller (1818–1899) published extensively on mosses, dividing them into three classes: Schistocarpi (having capsules with longitudinal valves), Cleistocarpi (capsules without an operculum) and Stegocarpi (capsules with an operculum). He further divided Stegocarpi into Acrocarpi and Pleurocarpi in his *Synopsis Muscorum Frondosorum* (Müller, 1848–1851).

With the recognition of the inflorescence characters (principally the sporophyte as it is recognised today) and the elucidation of the structure of the peristome (endostome, exostome and horizontal, basement membrane), peristome structure and sexuality became accepted as being of greater diagnostic importance than gametophyte characters such as habit, leaves and branching patterns. A key to 33 British genera was produced by Hooker & Taylor (1818) based on the peristome, the position of the sporophyte and calyptra form. Other researchers continued to give sporophytic characters prominence, and the terms acrocarpi (terminal sporophyte) and pleurocarpi (lateral sporophyte) were introduced by Bridel (1818) as primary character states in true mosses. Bridel (1826, 1827) recognised 91 genera of acrocarpous and 31 genera of pleurocarpous mosses.

Classifications began to follow what was called a 'Natural System', e.g. Bridel recognised a hierarchical system of classes, orders and families. Müller (1848–1851) and Schimper (1856) separated cleistocarpous and stegocarpous mosses while also recognising acrocarpi and pleurocarpi. Schimper, although largely unrecognised for his contribution, was the first to introduce the concept of families of bryophytes in the modern sense (Buck & Crum, 1990).

William Mitten emphasised peristome characters, dividing true mosses into Arthrodonti (with a peristome of two parts: an external layer of 16 articulated cells and an internal layer comprising a folded membrane) and Nematodonti (with a peristome of non-articulated

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filaments) (Mitten, 1859). He was critical of Bridel's and Schimper's use of growth form characters, noting that in some genera (e.g. *Fissidens*) the sporophyte might be borne on various parts of the stem.

Significant advances in moss nomenclature and classification were made by Max Fleischer (1861–1930) in *Die Musci Flora von Buitenzorg* (Fleischer, 1900–1923). Meanwhile, Viktor Brotherus (1849–1929) refined Fleischer's classification in *Die Natürlichen Pflanzenfamilien* (Brotherus, 1901–1909, 1924–1925) which remains the only attempt to treat all known families, genera and species of mosses, i.e. a global flora. The number of moss genera rose to 660 in the time of Brotherus, with the acrocarps accounting for 43 per cent of species and the pleurocarps 57 per cent (see Buck & Crum, 1990). Many bryologists (e.g. Grout, 1928–1940 for North America; Sim, 1926 for South Africa) have followed the classifications of Fleischer and Brotherus (see Vitt, 1984).

A paper by Henri Philibert on peristome structure (Philibert, 1884) had a profound impact on moss classification, especially following its translation into English (Taylor, 1962). Philibert recognised Mitten's (1859) terms 'nematodontous' and 'arthrodontous' as the two primary types of peristome. He further divided the arthrodontous peristomes into haplolepidous and diplolepidous types based on the origin of the peristome layers.

Peristome attributes have been used widely as the basis for moss classification because they reflect phylogeny (Dixon, 1932; Crosby, 1974, 1980; Vitt, 1984; Vitt *et al.*, 1998). Modern classifications are based on "…what might be called the Philibert-Dixon principle: in constructing a classification of mosses primary weight should be given to characters of the sporophyte particularly the peristome; mosses with similar gametophytes but different peristomes must not be grouped together with mosses that have similar peristomes…" (Crosby, 1974). Peristomial characters are valuable in phylogenetic speculation, and basic developmental patterns in moss peristomes are reliable indicators of higher systematic relationships, probably above the rank of family (Buck, 1991; Goffinet & Buck, 2004). However, a strong reliance on peristomial attributes and superficial morphology is inappropriate for pleurocarpous families where gametophytic characters are more reliable and provide a more stable basis for familial classification (Buck, 1991; Hedenäs, 1998). The position of the perichaetium and sporophyte, as used by Bridel and Schimper, appears to represent parallel evolution, as pleurocarpous forms occur among acrocarpous taxa. Capsule dehiscence as a taxonomic character (Müller, 1848–1851) has been shown to be artificial with cleistocarpous forms occurring in a number of unrelated taxa, this being an adaptive response to xeric habitats (Vitt, 1984).

Detailed morphological and Scanning Electron Microscopy (SEM) studies have facilitated a more accurate interpretation of peristome structure (Edwards, 1984) and have added considerably to the understanding of intra- and interspecific variation (e.g. Vitt, 1984; Shaw, 1985a, b; Shaw *et al.*, 1987; Lewinsky, 1989, 1990; Bruggeman-Nannenga & Berendson, 1990; Bruggeman-Nannenga & Roos, 1990, Buck & Goffinet, 2000).

The first systematic arrangements of genera, families and orders since Brotherus were based on refined taxonomic concepts using evidence from peristome morphology (Edwards, 1984) as well as analysing other data such as gametophyte structure using cladistic methods (Vitt, 1982a, 1984). The classification of pleurocarpous mosses has been further reviewed by Buck & Vitt (1986) and Hedenäs (1994, 1995, 1996a, 1996b, 1998). More recent studies by Vitt *et al.* (1998), Buck & Goffinet (2000) and Goffinet & Buck (2004) have incorporated additional molecular and morphological data to develop more accurate phylogenies for the mosses.

Data from other techniques have also being used to clarify relationships: electrophoresis (Wyatt *et al.*, 1989b, 1993; Stoneburner *et al.*, 1991b); cladistic analysis (Vitt, 1984; Buck & Vitt, 1986; Buck, 1993; Hedenas, 1994, 1995, 1996a, 1996b, 1996c, 1998; Goffinet & Buck 2004); molecular techniques (Mishler *et al.*, 1992; Goffinet & Buck, 2004); ultrastructural studies (Duckett, 1986; Duckett & Renzaglia, 1988; Ligrone & Gambardella, 1988; Brown & Lemmon, 1993); cytogenetics, reproduction and population genetics (Newton, 1984a, 1988; Wyatt & Anderson, 1984; Wyatt *et al.*, 1993; Newton & Mishler, 1994; Wyatt, 1994; Cove, 2000); and chemotaxonomy (Mues, 1990, 2000; Zinsmeister & Mues, 1990).

Cladistics has shown that many genera and families are polyphyletic rather than monophyletic as was previously assumed. This has led to new concepts of individual families, genera and species, e.g. in Orthotrichaceae (Goffinet & Vitt, 1998) and Pottiaceae (Zander, 1993). The recent improvement in techniques for extracting, amplifying and sequencing DNA from fresh as well as older herbarium material has enabled the analysis of chloroplast, mitochondrial and nuclear DNA and the use of increasing numbers of different loci.

Enthusiasm for new molecular tools and techniques of analysis should not, however, mean the abandonment of older, well-established methods. While most studies are rigorous in confirming the identity of specimens sampled, errors can result in inconsistencies between studies. These can be traced to, for instance, the misidentification of herbarium collections, e.g. *Mittenia* in Goffinet *et al*. (2001), while errors in checking the matrix in which the *rps*4 sequence for *Pleurophascum* was incomplete led to this genus being mistakenly transferred to the Bryales (Buck & Goffinet, 2000; Goffinet *et al.*, 2001). There is still considerable debate as to whether molecular or morphological features are inherently better sources of information for estimating phylogeny (Goffinet *et al.*, 2004b). According to Goffinet & Buck (2004), "…it is, indeed, the history of morphological transformation that defines taxa or of the distribution ranges of the species that justify the investment into phylogenetic approaches. A revival of critical morphological and anatomical studies is, however, imperative if major clades are to be diagnosed by characters rather than their genomes."

In bryophyte classification, the dilemma has always been to determine the relative importance of the gametophyte and sporophyte generations, and this is influenced by interpretations of evolutionary processes. Thus, for example, parallel evolution resulting from adaptation might result in similar features occurring in unrelated taxa (Vitt, 1981; Hedenäs, 1998). Whereas, in the past, emphasis was placed on either the sporophyte (particularly the peristome) or gametophyte, more recent classifications have tended to view both generations as having equal weight. Crosby (1980) considered that orders could best be characterised by peristomial attributes, whereas families and infrafamilial taxa are better defined with reference to gametophytic characters. This is borne out in Goffinet & Buck's (2004) most recent scheme of classification.

Two recent, highly significant publications, *Bryophyte Biology* (Shaw & Goffinet, 2004) and *Molecular Systematics of Bryophytes* (Goffinet *et al.*, 2004b), include discussion of molecular methods and the evolution of bryophytes and other land plants. New information has led to revised classifications of mosses, and Buck & Goffinet (2000), further modified by Goffinet & Buck (2004), have reassigned many genera into different or newly described families. Streimann & Klazenga (2002) have based their classification of Australian mosses on Buck & Goffinet (2000) with a few more recent modifications.

The classification of mosses continues to come under review at all levels. Modern, global studies are increasingly concerned with higher level classification as well as familial and generic concepts among acrocarpous and pleurocarpous taxa. The taxonomic level at which a 'group' is now recognised, e.g. class, subclass, order, family, genus etc., can vary, and while there is some broad agreement among bryologists concerning the higher level classification, there is often disagreement regarding the most appropriate taxonomic rank (Klazenga, 2005). For example, while Vitt (1984) recognised a single class of mosses (Bryopsida) with three subclasses, Schofield (1985) acknowledged a single class Bryopsida (Musci) with seven subclasses. Smith (1978), Magill (1981) and Eddy (1988–1996) documented three classes (Sphagnopsida, Andreaeopsida and Bryopsida), while Crandall-Stotler (1986) gave them divisional status. Mishler & Churchill (1984) and Mishler *et al.* (1992) have applied cladistic methods in an attempt to clarify the phylogenetic relationships of bryophytes. They recognise 6 orders of mosses: Sphagnales, Andreaeales, Tetraphidales, Polytrichales, Buxbaumiales and Bryales (see also Goffinet & Vitt, 1997).

The recent classification of Buck & Goffinet (2000), updated by Goffinet & Buck (2004) to incorporate additional information based on molecular studies, has introduced new categories, namely Superclasses I–V:

Superclass I, comprising Class Takakiopsida (one order, one family);

Superclass II, comprising Class Sphagnopsida (two orders, two families);

Superclass III, comprising Class Andreaeopsida (one order, one family);

Superclass IV, comprising Class Andreaeobryopsida (one order, one family);

Superclass V includes the majority of mosses in four classes: Oedipodiopsida (one order, one family); Polytrichopsida (one order, one family); Tetraphidopsida (one order, one family); and Bryopsida, with many subclasses, orders and more than 100 families.

Life History, Morphology and Terminology

Mosses are eukaryotic, chlorophyllose, leafy, annual or perennial plants. Their life histories are characterised by the alternation of a 'haploid', autotrophic organism (the gametophyte), with an attached and partially dependent, 'diploid' generation (the sporophyte). The sporophyte has a terminal capsule which, although it is photosynthetic until spore dispersal, is short-lived and of determinate growth. Meiosis takes place within the capsule to produce haploid spores that are discharged and dispersed to give rise to the next gametophyte generation.

The gametophyte reproduces sexually before sporophyte production; it often also reproduces asexually or by fragmentation. This, and the ability to regenerate in some cases from a single cell, allows mosses to be readily dispersed and enables rapid colonisation of pioneer niches even in the absence of sexual reproduction.

Stages of the gametophyte generation

A. A haploid *spore* is the first cell of the gametophyte generation,

B. The spore germinates to produce a richly branched, filamentous or plate-like *protonema*,

C. Buds arise from the protonema to produce leafy *gametophores* (moss plants). Mature gametophores are attached to the substratum by *rhizoids* (no true roots are developed),

D. The gametophyte produces sex organs by mitosis: the *antheridium* containing sperm ('male') and the *archegonium* containing the ovum ('female'),

E. A biflagellate sperm with whiplash flagella moves down the neck of the archegonium in a film of water to fertilise the ovum,

F. Following fertilisation, the *calyptra* (derived from archegonial tissue) covers and protects the apex of the sporophyte during capsule development.

Stages of the sporophyte generation

G. The diploid, embryonic sporophyte develops from the fertilised ovum. The mature sporophyte consists of a *foot* embedded in the gametophore and a *seta* (or stalk) with a terminal *capsule*,

H. The capsule consists of a complex, protective wall surrounding the *spore sac* and a central *columella*. In most mosses, a *peristome*, which can assist in spore dispersal, surrounds the capsule mouth. The peristome is covered by a terminal *operculum* or lid until the spores are ready to be shed,

I. Within the spore sac, *sporocytes* (spore mother cells) undergo meiotic division to produce haploid *spores*. The spores enlarge and form a protective wall before being dispersed after the operculum is shed.

The nature of the two generations, the absence of lignified tissues in mosses (Geiger, 1990) and the requirement of water for sexual reproduction have imposed restrictions on the size of these plants. Evolutionary processes, such as mutations and natural selection, can operate at any stage of development and have resulted in many adaptations for reproduction, dispersal and survival.

Morphology and terminology

A appreciation of the morphology and anatomy of mosses is essential for distinguishing between species. Moss specimens are among the easiest to collect and preserve, and guidelines and useful hints can be found in Scott & Stone (1976), Catcheside (1980), Schofield (1985) and Meagher & Fuhrer (2003). In spite of their comparatively small size, the morphology of mosses is complex, and structural as well as physiological adaptations have enabled mosses to adapt to a broad range of habitats.

Well-illustrated publications providing useful information on morphology include Flowers (1973), Watson (1974), Hébant (1977), Schofield & Hébant (1984) and Schofield (1985). The summary of morphology provided by Buck & Goffinet (2000) is particularly useful for those intending to study mosses. The basic reference for terminology is *Glossarium Polyglottum Bryologie* (Magill, 1990), while a richly illustrated, comprehensive glossary of bryological terms has also been published (Malcolm & Malcolm, 2000). Moreover, Buck *et al.* (2002) and Meagher & Fuhrer (2003) illustrate the broad range of morphological and anatomical variation in Australian mosses, while a glossary of technical terms is also found in the current volume.

The Gametophyte

Morphological characteristics of the gametophyte important for the identification of mosses include habit, growth form and branching pattern, stem anatomy and surface features, reproductive structures and sexuality, leaf characteristics including laminal anatomy and costal structure, rhizoids and the calyptra, spore size and ornamentation.

Spores

The moss spore, the first stage of the gametophyte generation, is usually a single cell consisting of a protective wall (often distinctively ornamented and containing sporopollenin similar to pollen grains), a nucleus, chloroplasts, stores of lipid, starch and protein and other organelles (Mogensen, 1983).

The dimensions of spores and the number produced vary considerably among mosses: 4–16 spores of up to 200 µm diam. in *Archidium*; an estimated 350,000–500,000 spores (each c. 13 µm diam.) in capsules of *Funaria hygrometrica*; 470,000 spores (14 µm diam.) in *Orthotrichum cupulatum*; 1,000,000 spores (10 µm diam.) in capsules of *Tortula muralis*; and 50–80 million spores in *Dawsonia*, each 8–10 µm diam. (Ingold, 1959). Some spores remain viable for only 1–2 hours while others can germinate one or more years after sporogenesis. Moreover, some mosses produce spores of two distinct size classes (e.g. in *Macromitrium* and *Schlotheimia*; Ramsay, 1979). In a few taxa, spores can appear multicellular as a result of pregermination in the capsule (e.g. in *Andreaea*, *Muelleriella*, *Eucamptodon* and *Dicnemon*).

Protonema

The moss protonema is usually ephemeral, but it persists in some groups, e.g. *Mittenia* and *Viridivellus* (Stone, 1961, 1976) and Ephemeraceae (Stone, 1996). The protonema consists of caulonemal cells (lacking chloroplasts), including rhizoids with oblique walls, as well as chloronemal cells (containing chloroplasts). The principal role of the caulonema is colonisation, while rhizoids function in attachment and nutrient uptake during colonisation as well as propagation by tubers. The functions of the chloronema are assimilation and propagation by the production of asexual gemmae (Duckett *et al.*, 1998). Although usually filamentous, the form of the protonema can vary and it is diagnostic in some mosses, e.g. *Mittenia* and *Calomnion*. By contrast, the protonema is plate-like in genera such as *Sphagnum* and *Andreaea*.

The Gametophore

The gametophore originates from a single, usually tetrahedral, apical cell bud on the protonema. This bud gives rise to leaves, lateral buds and the outer section of the stem from

outer initials, while the inner initials form the inner stem tissues (Crandall-Stotler, 1980). The gametophore, the structure generally recognised as a 'moss plant', is usually perennial and grows by innovations or underground rhizomes. The pattern of growth (e.g. upright, trailing, dendroid or prostrate) can characterise a family or genus, e.g. the trailing growth form of the Meteoriaceae, and the dendroid Hypnodendraceae.

Gametophores range in size from less than 1 mm tall (e.g. *Goniomitrium*) to upright stems 20–60 cm tall (e.g. *Dawsonia*), while prostrate or pendulous forms (e.g. *Papillaria*) or aquatic forms and those in moist habitats (e.g. *Brachythecium*) can be even longer.

Stems

The stem of the gametophore can be upright, prostrate or pendulous, simple or branched, and the stem surface can be smooth, bear paraphyllia or it can be covered with a tomentum of rhizoids. Paraphyllia (stem outgrowths) or pseudoparaphyllia (outgrowths protecting branch primordia) on the stems of some pleurocarpous mosses are either filamentous or leafy, and they can be diagnostic for certain genera. Types of axillary hairs found in some mosses can also be highly distinctive (Griffin, 1990).

Stem anatomy has been much used in differentiating taxa at all taxonomical levels (Buck & Goffinet, 2000). Although some stems contain elongated cells with thickened walls (stereids) and have a conducting system of hydroids for internal movement of water, no true lignin is produced (Schofield & Hébant, 1984; Geiger, 1990; Mues, 2000). Leptoids, involved in the translocation of photosynthates, are found only in members of the Polytrichales. Transverse sections of stems reveal the presence or absence of a central strand (with or without stereids), the epidermis and the type of cortical cells present. Absorption of water and nutrients usually occurs through the surface of the leaves and stems, although the translocation of carbohydrates can also include movement along microtubules in leaf costae and laminal cells (Duckett *et al.*, 1997).

The branching pattern of moss stems can be one of two types: 1) monopodial or indeterminate, e.g. in pleurocarpous mosses where the apical bud persists and lateral growth occurs from axillary buds with gametangia on lateral branches; or 2) sympodial and determinate, where the apical bud is replaced following production of gametangia, and branching is continued by lateral meristems. The latter type is found in most acrocarpous species. See La Farge-England (1996) and Buck & Goffinet (2000) for further details.

Leaves

Important leaf characters include size, shape, colour, insertion on the stem, the nature of the leaf apex, margin and base, and the structure and extent of the costa. Many of these features are well illustrated in Malcolm & Malcolm (2000) and Buck *et al.* (2002). At a microscopic level, accurate identification can sometimes depend on assessing the thickness of the leaves by sectioning (whether comprising one, two or more layers of the cells) and the shape, dimensions and structure of costal, epidermal, marginal and basal laminal cells. Leaf sections are often required for complex leaves, e.g. *Leucobryum* and *Polytrichum*. The presence of lamellae on the leaf surface is characteristic of the Polytrichales, e.g. *Dawsonia* and *Polytrichum*. The arrangement of leaves on the stem (whether spiral, complanate or distichous) and their appearance and stance when wet and dry can also be diagnostic.

Leaf cell anatomy

Leaf cells can be chlorophyllose, pigmented or hyaline. Cells of different size, shape, orientation and wall thickness can occur in different parts of the lamina (e.g. margin, upper lamina, basal lamina or juxtacostal), while specialised alar cells can sometimes be seen in the basal corners of the leaf, e.g. in Sematophyllaceae, Dicranaceae and Dicnemonaceae. Cell surfaces can be smooth (Bryaceae), mammillose or papillose (Orthotrichaceae and Pottiaceae), while papillae themselves can have a simple or quite complex structure.

Leaf costa

A costa (or leaf vein/midrib) can be present (Bryaceae, Dicranaceae) or absent (Sematophyllaceae, Hypnaceae). When present, it can be single or double (two distinct costae), and it can extend part of the way up the lamina, reach the apex (percurrent), or even extend well beyond the apex (excurrent) as a hairpoint. Costal cells range from uniform to markedly heterogeneous and thin- or thick-walled. Details of costal anatomy (best seen in transverse section) can also be diagnostic. In *Leucobryum*, the costa occupies most of the leaf and consists of large hyaline cells enclosing a central layer of chlorophyllose cells. In *Campylopus*, the costa occupies up to one-third of the laminal width at its base and had a complex structure; in the Polytrichales, longitudinal, chlorophyllose ridges or plates are found on the adaxial surface of the costa.

Rhizoids

Filamentous rhizoids anchor the protonema and gametophore in the substratum. They can be present only at the stem base or they can form a dense, felt-like tomentum covering large areas of the stem (Buck & Goffinet, 2000). Rhizoids are smooth (Sematophyllaceae) or papillose (Bryaceae, Bartramiaceae), with thin or thick, often oblique walls, and they are often pigmented (Crundwell, 1979). Some have asexual reproductive structures such as tubers (Bryaceae).

Asexual reproductive structures

Mosses produce a range of specialised, vegetative propagules on protonemata, rhizoids, leaves, stems or in stem axils (e.g. in Bryaceae, Pottiaceae, Calymperaceae and some Orthotrichaceae; Lewis & Smith, 1977; Duckett & Ligrone, 1992). Occasionally, stem apices are themselves deciduous and propagative (e.g. in *Campylopus clavatus*), or flagelliform shoots with reduced leaves can be produced (e.g. in *Wijkia extenuata*). Leaf fragments and fragile or deciduous leaves can sometimes regenerate new gametophores, and such structures can be taxonomically informative, e.g. in *Pohlia* and Bryaceae, Pottiaceae and Calymperaceae.

Gametangia and sexuality

The sexuality of a moss is determined by the type of sex organs (gametangia) present and their arrangement and position on the gametophore. An ovum is produced in the basal venter of a flask-shaped archegonium. Archegonia, often intermixed with sterile paraphyses, are aggregated in a perichaetium sheathed by specialised perichaetial leaves that persist after fertilisation and sheath the base of the developing sporophyte. Their shape and structure, especially the inner perichaetial leaves, can differ significantly from the vegetative leaves of the same species (e.g. in *Eucamptodon* and *Holomitrium*). The perichaetia (and eventually the sporophyte) are produced from the shoot apex (acrocarpous) or on lateral branches (pleurocarpous).

Male gametes (antherozoids) are produced in stalked antheridia, mixed with paraphyses, which are usually grouped into the perigonium surrounded by perigonial leaves. Perigonial leaves sometimes differ from vegetative leaves, and in some mosses (e.g. Polytrichales, *Bryum* and *Breutelia*) the perigonium forms a splash cup enabling sperm to be more readily and effectively dispersed by raindrops.

Mosses with perichaetia and perigonia on separate plants are termed *dioicous*; those in which both occur, but separately, on the same plant are *autoicous*. Among autoicous species, those known as *cladautoicous* have the perichaetia and perigonia on different branches of the same plant, whereas in *gonioautoicous* mosses the perichaetia and perigonia occur on the same branch, while *rhizoautoicous* forms have the male sex organs produced on rhizoids at the base of the female (Buck & Goffinet, 2000). In *synoicous* mosses, the antheridia are mixed with archegonia in the same perichaetium, while in *paroicous* species the perigonia and perichaetia are not mixed but occur in different leaf axils of the same plant. Some taxa have a mixture of sexual arrangements, subtle variations can occur, and the terminology and classification of sexual conditions in mosses can also be confusing (Wyatt & Anderson,

1984; Wyatt, 1985; La Farge-England, 1996; Buck & Goffinet, 2000; Malcolm & Malcolm, 2000). In dioicous species, the male and female plants can be dimorphic, the most extreme manifestation of which has the male reduced to an epiphytic dwarf plant (*pseudoautoicous* or *phyllodiocous*) on the leaves or stems of the female (e.g. in *Macromitrium*, *Racopilum*, *Leucobryum* and Dicnemonaceae).

Calyptra

The embryonic sporophyte is enclosed and protected by a hairy or membranous calyptra which is gametophytic in origin and which grows from the base of the archegonial venter. As the sporophyte forms and the seta elongates, the calyptra usually ruptures near the base, leaving a remnant vaginula, the remainder partly or completely enclosing and being carried up with the developing capsule. The calyptra both protects the young sporophyte and determines its shape, often until maturity, at which time it becomes detached from the capsule. Calyptrae vary in shape, size, surface features and manner of splitting. Two basic types are recognised, *viz*. mitrate (conical and undivided or equally lobed at the base) and cucullate (slit up one side).

The Sporophyte

The sporophyte, consisting of a foot, seta and capsule, is comparatively uniform and diagnostic for groups such as the Sphagnopsida, Andreaeopsida and Polytrichopsida. However, great variation is found among the Bryopsida both at family and genus levels; in the more advanced and specialised taxa a considerable morphological range can occur even within a genus or species. Apart from shape, the most important characteristics of the sporophyte are its position on the gametophore, the type of exothecial cells, the location and type of stomata, the presence or absence of an annulus, the shape of the operculum, and the ontogeny and structure of the mouth of the capsule including the development and structure of the peristome.

Foot

The sporophyte is attached to the stem apex of the gametophore by a anchoring and absorptive ‘foot’. The foot, the stem apex and the adjacent placental region vary in their structure and dimensions and, in all mosses except *Sphagnum*, they contain the transfer cells that are essential for the nutrition of the sporophyte (Ligrone & Gambardella, 1988; Buck & Goffinet, 2000).

Seta

The seta is a simple, leafless, photosynthetic stalk that elevates the capsule above the gametophore. It is usually a solitary structure, although in certain genera (e.g. *Dicranoloma*; Klazenga, 2003), several can originate from the same stem apex. The seta elongates before the capsule begins to expand and before sporogenesis takes place, rather than after sporogenesis, as is the case with liverworts. It has a central conducting system of hydroids (along with leptoids in the Polytrichopsida) and stereids that keep it erect and rigid. Differentiation of surface cells enables it to twist when dry. The seta varies in length, being especially short in taxa with largely immersed capsules (e.g. *Acaulon* and *Ephemerum*). In most mosses, however, the seta carries the capsule well above the gametophore. The pattern of twisting of the seta can be diagnostic, e.g. in some Orthotrichaceae (Goffinet & Vitt, 1998). Transverse sections show the form of the conducting system and the nature of the cell types that determine the seta structure and twisting pattern.

Capsule

The functions of the moss capsule are centred on the production and dissemination of spores. Capsules can be immersed, emergent or exserted, depending on the length of the seta. The internal structure and development of the capsule and the origin and form of the peristome at its mouth are characteristic for different types of moss. In most, the capsule consists of an

urn with a complex wall composed of a thickened, non-chlorophyllose outer layer of exothecial cells subtended by one or several layers of chlorophyllose cells.

The capsule wall encloses an amphithecium that gives rise to the exothecium and the layers at its apex from which the peristome is derived. The endothecium produces the spore sac in which spores are formed following meiosis as well as a central, non-sporogenous region, the columella (Buck & Goffinet, 2000). An apophysis (or swelling) can sometimes be seen at the point of attachment to the seta (e.g. in *Trematodon*). Immersed or superficial stomata are often present, especially at the base of the capsule, and these are diagnostic for some groups, e.g. the Orthotrichaceae. The mouth of the capsule is usually surrounded by an annulus or ring of cells, and a lid-like operculum covers the mouth until the spores are ready to be shed.

In most mosses, the peristome forms a ring around the mouth of the capsule. Spore dispersal in peristomate species is regulated by hygroscopic movement of the peristome teeth; in cleistocarpous species spores are shed following the breakdown of the capsule wall; while gymnostomous species lack a peristome, and spores are released from the more rudimentary capsule mouth.

Peristome

The peristome comprises 4, 8, 16, 32 or 64 teeth arranged in one or two, rarely multiple, rings inside the mouth of most moss capsules. However, there is considerable variation in the morphology, anatomy and action of the peristome (see Edwards, 1984; Shaw & Robinson, 1984).

Nematodontous peristomes occur in the Polytrichopsida and Tetraphidopsida. In the former, each tooth is composed of several, whole elongate cells, and the peristome consists of 16–64 short, rigid, multicellular teeth in a single circle. In the Polytrichales (except *Dawsonia*), the apex of the columella is expanded to form a plate-like epiphragm. Expansion and contraction of the epiphragm opens and closes the space between the teeth, possibly regulating spore dispersal.

Arthrodontous peristomes occur in all members of the Bryopsida and are derived from the cell walls only (not whole cells) of the three innermost layers of the apical amphithecial tissue: the *inner peristomial layer* (IPL) proximally continuous with the spore sac; the middle or *primary peristomial layer* (PPL); and the *outer peristomial layer* (OPL). The peristome usually consists of one or two rings of triangular or linear appendages (exostome teeth and endostome segments). These are formed from differentially thickened periclinal wall-pairs that remain standing after the breakdown of the rest of the cells (Edwards, 1984). Cell patterns on the face of peristome teeth provide the simplest and most reliable method of establishing homologies between taxa. A peristomial formula indicates the number of cells from each of the layers (OPL, PPL, IPL) involved in the production of each tooth or segment (Edwards, 1984; Buck & Goffinet, 2000). The final divisions of the innermost peristomial layer determine the different types of arthrodontous peristomes (Shaw & Robinson, 1984; Buck & Goffinet, 2000).

In arthrodontous peristomes, the columella does not expand at its apex, but is attached to the operculum and usually breaks when the operculum is shed. Hygroscopic movement of the exostome teeth frequently plays an role in hindering or facilitating spore release, while the endostome is generally considered to play only a minor role in spore release (Miller & Neumann, 1988). Although arthrodontous peristomes have diverged into many different forms, two major types can be recognised: diplolepidous (with an exostome and endostome) and haplolepidous (with an endostome only). A heterolepidous type, found in *Encalypta*, is thought to be intermediate (Goffinet & Buck, 2004).

Diplolepidous peristomes are found in families such as Bryaceae, Mniaceae, Rhizogoniaceae, Hypnaceae and Hookeriaceae, and consisting of two concentric circles of teeth. The teeth in one circle can be opposite to or alternate with those of the second.

The outer circle (exostome) consists of 16 robust, triangular teeth (sometimes as 8 pairs) each with trabeculae derived from the cross walls of a single column of cells on the inner

face, and two columns of plates separated by a zig-zag line on the outer face (Edwards, 1984). The exostome teeth, derived from wall-pairs between the OPL/PPL, can be highly ornamented on the outer and/or inner surface. The type of ornamentation, the number of teeth and the extent to which they are fused are often diagnostic. The inner circle (endostome) consists of a delicate inner membrane bearing a network of cell patterns on each side. This membrane, derived from wall-pairs of the PPL/IPL, is divided above into 16 often perforated segments. Between the endostome segments are 16 groups of 2–4 fine cilia also attached to the basement membrane (Buck & Goffinet, 2000). The endostome segments usually alternate with the exostome teeth or, more rarely, oppose them (*Funaria*-type). The number of segments and cilia and their ornamentation on both faces can also be diagnostic.

Haplolepidous peristomes: These are characteristic of the Dicranaceae and Fissidentaceae, are always of one layer, and are homologous with the endostome (Buck & Goffinet, 2000). Each of the 16 teeth consists of two concentric layers of fused cell walls derived from thickening of the contiguous wall-pairs derived from the PPL/IPL. The outer surface of each tooth consists of a single tier of cells, while the inner surface has 1.5 cells per tooth. The 16 teeth of this single ring sometimes split into 32.

Reproductive Biology, Cytology and Genetics

While some mosses reproduce only sexually and lack specialised asexual structures, others rarely reproduce sexually but have one or more asexual or vegetative means of reproduction. Only a few taxa reproduce exclusively by vegetative means.

Sexual reproduction

A range of sexual reproductive systems maintains a high degree of genetic flexibility in mosses (Longton, 1976). The breeding systems and degree of mating success at the time of fertilisation influence the success of the species (Wyatt, 1982) and can also provide important diagnostic characters (Longton, 1982).

Dioicous mosses are slightly more common than monoicous taxa (Wyatt & Anderson, 1984), and most Australian monoicous mosses are autoicous. However, the ancestral sexual form is widely considered to be dioicous (Longton & Schuster, 1983; Vitt, 1984) since dioicy is more widespread among the ‘primitive’ mosses (Anderson, 1980; Smith, 1979).

Sexuality is usually consistent within a species but often differs between species of the same genus, e.g. in *Bryum s. lat.* spp. (dioicous, synoicous or autoicous), *Grimmia* spp. (dioicous or autoicous) and *Macromitrium* spp. (dioicous, including pseudautoicous and phyllodioicous, or autoicous). The basis for sexuality can be related to cytological factors, and doubling of the chromosome number can shift a species from dioicy to monoicy (Vitt, 1968; Smith, 1978; Longton, 1982; Ramsay & Berrie, 1982; Ramsay & Spence, 1996). Moreover, the phenomenon of epiphytic dwarfism in males, widespread in the mosses (Ramsay & Berrie, 1982), is sometimes related to anisospory, e.g. in *Macromitrium* (Ramsay, 1979), and it may also have a cytological basis.

The potential advantage of dioicy is that it promotes outcrossing and increases genetic variability thus providing greater adaptability to environmental change (Mishler, 1988). It also enables mosses to specialise as either male or female parents on slightly different environmental resources (e.g. dwarf males) thereby reducing intraspecific competition. In males, the production of splash cups (e.g. in Polytrichidae and Bartramiaceae) can facilitate the dispersal of gametes, while females plants can be taller to enhance spore dispersal. Dwarfism of males that are epiphytic on the female, increases the possibility of outcrossing in epiphytic species at least for the first generation (Ramsay, 1983; Ramsay & Vitt, 1984).

Selection acts directly on the gametophyte and, being haploid, there is apparently no heterozygosity except for the cytological evidence that initial duplication (functional polyploidy) has occurred at some time in the past to produce gametophytic chromosome

numbers such as 10, 11, 12, 13, etc. (Ramsay, 1983; Newton, 1986). The gametes, produced by mitosis, are genetically identical on any one plant. In monoicous species, particularly synoicous and paroicous forms, obligate self-fertilisation and inbreeding can result from close proximity of male and female gametangia. Therefore, it is no more valuable than vegetative reproduction, unless species are protandrous or protogynous to ensure outcrossing. However, the majority of monoicous species are autoicous, and often the distance between perigonia and perichaetia is such that the likelihood of outcrossing is enhanced (Longton & Miles, 1982). Monoicy is favoured where there is a low density of reproductive individuals in the population, e.g. in colonising or weedy species, and it is thought to have a better potential for long-range dispersal. Other isolating mechanisms, such as genetic incompatibility, can also promote outcrossing in monoicous species, for example *Weissia* clones can have different numbers of *m*-chromosomes (Anderson & Lemmon, 1974; Anderson & Snider, 1982).

Ecological trends in breeding systems can be related to environmental pressures. Thus, monoicy is common in drier habitats such as dry deserts, polar deserts and dry micro-environments in otherwise mesic habitats, while dioicy is more frequent where water availability is dependable (Wyatt, 1982).

In Australia, very little research has been carried out on the phenology and reproductive biology of mosses, and we know little of the mechanisms and importance of reproduction in individual species. Some studies have been published for *Macromitrium* (Ramsay, 1988a, 1988b; Ramsay & Vitt, 1986) and *Dicranoloma* (Ramsay, 1985; Milne, 1997), while research has yet to be undertaken on the many different mechanisms that ensure reproductive success among arid zone and epiphytic mosses.

Asexual reproduction

Asexual reproduction is very common in mosses, and while it contributes little to increased genetic variation within species, it enables rapid colonisation and expansion of moss colonies at times when sexual reproduction does not or cannot occur. Increase in size and in numbers of individuals in a clone results from the production of new stems, fragmentation of an existing colony or death of older parts and regeneration from new apices at the edges. In some cases, diaspores that are not dispersed can grow to form new shoots among old or dead plants (e.g. *Archidium, Campylopus* and *Bryum s. lat.*).

Experimental studies suggest that vegetative diaspores or gemmae of various kinds, including filamentous structures in Calymperaceae, *Tortula papillosa*, *T. pagorum* and *Macromitrium brachypodium*, and bulbils or tubers in Bryaceae (Egunyomi, 1984; Schofield, 1985; Imura & Iwatsuki, 1990; Ramsay, 1988b; Spence & Ramsay, 1996) are often more likely to be successful than spores in the spread of a moss colony (Miller, 1984; Longton, 1988). Diaspores are produced in great numbers in transient, open, extreme or unpredictable environments as well as by epiphytic species for which colonisation and rapid population growth are essential (Wyatt, 1994). Diaspore viability varies depending on the species, but it has been calculated from 2–12 months (Egunyomi, 1984). Leaf fragments and fragile or deciduous leaves can also regenerate new gametophores. In some species, several different forms of asexual reproduction can occur simultaneously, e.g. in *Dicranella cardotii*, *Gemmabryum eremaeum* and *G. pachythecum* (Bergstrom & Selkirk, 1987; Duckett & Ligrone, 1992, Spence & Ramsay, this volume).

Cytology and genetics

Bryophytes have contributed significantly to the broad understanding of cytology and genetics. The comparatively high incidence of heterochromatin, specialised *m*-chromosomes, sex chromosomes and certain other meiotic attributes distinguish bryophyte cytology from that of vascular plants (Anderson, 1984). The fundamental cytological differences between the major bryophyte groups are of particular interest in view of the similarities in their life histories. The Hepaticopsida (liverworts) are relatively conservative and stable with respect to chromosome number (n = 8, 9 or 10; 75 per cent with n = 9) with limited polyploidy, while the Anthocerotopsida (hornworts) have n = 5 or 6 (Fritsch, 1991; Goldblatt & Johnson,

1994–2003). By contrast, mosses are more diverse in terms of chromosome number and in cytological behaviour. The Sphagnopsida have a unique chromosome number ($n = 19 + 2m$) with some polyploidy. The Andreaeopsida have $n = 10$ or 11 while the Takakiopsida have $n = 4$ or 5. Cytological uniformity is seen in Polytrichopsida which have numbers based on $n = 7$ large chromosomes or its multiples 14 and 21. The Tetraphidopsida have $n = 7$ or 8 chromosomes (Fritsch, 1991; Goldblatt & Johnson, 1994–2003).

In the highly diverse Bryopsida, chromosome numbers can vary within families, genera or even species (Fritsch, 1991) with numbers such as $n = 4$, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14 and multiples to 66 (Pottiaceae) the commonest being $n = 6$, 7, 10, 11, 13, 14 and 20. The relatively uniform chromosome numbers of the diplolepidous, alternate, pleurocarpous mosses (56 families; $n = 10$ or 11) suggest a close relationship for these highly derived taxa, in contrast to diplolepidous, acrocarpous or cladocarpous species which have more diverse chromosome numbers, and which Vitt (1984) considered to be an older and more heterogeneous group.

While chromosome numbers appear to support some major taxonomic categories and are consistent within smaller, tightly defined taxonomic groups such as Polytrichopsida and Sphagnopsida, they are unpredictable in large families of colonising species such as the Pottiaceae, Bryaceae and Funariaceae. The amount of polymorphism in chromosome numbers, particularly in the Bryopsida, can usually be accounted for by cytological changes similar to those in vascular plants, e.g. hybridisation, polyploidy, aneuploidy and structural rearrangements (Newton, 1979, 1984b, 1986; Anderson, 1984).

Levels of ploidy rarely exceed three (n, $2n$ and $3n$) (e.g. in *Funaria hygrometrica* Hedw., 14, 28, 56), but levels are higher in some Pottiaceae and Bryaceae (Fritsch, 1991). Differences in chromosome number, particularly polyploidy and aneuploidy, act as highly effective sterility barriers for the different cytotypes and comprise “intersterile breeding units” (Smith, 1978). Because intraspecific polyploidy and aneuploidy are so frequent in mosses, it is difficult to infer evolutionary directions of change based on chromosome number alone (Anderson, 1964, 1984).

Chromosome data can be used as characters in bryophyte taxonomy in conjunction with traditional morphological ones (Anderson, 1984). Karyotype analyses and Geimsa C-banding (Newton, 1984a) have been used to elucidate the relationships among mosses with the same chromosome number (Inoue *et al.*, 1978; Ramsay, 1982, 1983). Most cytological studies on Australian mosses have been carried out by Ramsay (1964–1998; unpublished data), but there is still much to be done.

Some studies have addressed the genetics of individual taxa and populations (Wyatt, 1992, 1994), with methods such as electrophoresis revealing that bryophytes can differ substantially in their degree of genetic variation (Wyatt *et al.*, 1989a; Stoneburner *et al.*, 1991b), and isozyme analyses interpreting relationships between taxa (Wyatt *et al.*, 1989b, 1993; Goffinet 1995; van Zanten & Hofman, 1995; Goffinet & Buck, 1998). Electrophoretic studies on some genera, e.g. *Racopilum* (de Vries *et al.*, 1989; van Zanten & Hofman, 1995), *Plagiomnium* (Odrzykoski *et al.*, 1993; Wyatt *et al.*, 1989a) and *Atrichum* (Cummins & Wyatt, 1981), have allowed the recognition of the degree of genetic polymorphism within populations and, in some cases, by distinguishing unique diagnostic alleles, have determined the genetic differences between related species. Improvements in molecular techniques such as RAPDs and DNA sequencing have enabled significant research on the genetic diversity of Antarctic mosses, including tracing mutations within colonies in extreme climates (Skotnicki *et al.*, 1998a, 1998b, 2000, 2004) to resolve taxonomic uncertainties.

In recent years there has been analysis of genome size and karyotype in mosses (Cove, 2000). Where polyploid series are thought to exist it has been confirmed that there may be a correlation between chromosome number and genome size in some taxa (Volgmayr & Greilhuber, 1999; Cove, 2000). Studies on 132 moss taxa has demonstrated an approximately 12-fold variation in DNA content of haploid genomes in mosses compared with 1,000-fold range in the diploid genomes of angiosperms (Volgmayr & Greilhuber, 1999; Cove, 2000).

The traditional view of bryophytes as genetically impoverished organisms with limited potential for response to natural selection is not supported (Cummins & Wyatt, 1981; During & van Tooren, 1987; Shaw, 1991, 1992). “It is clear that both mosses and liverworts are genetically variable, that they possess considerable evolutionary potential and cannot be considered in any way unsuccessful or relict groups” (Smith, 1978).

Ecology, Distribution and Biogeography

Ecology

The early radiation of mosses was due to their ability to tolerate environmental conditions unsuitable for many other plants (Schofield, 1985). Today, mosses are widely distributed in many ecosystems including those at Arctic and Antarctic latitudes, alpine environments, the wet-tropics, arid regions and aquatic habitats (Schofield, 1981, 1985). Indeed, they are often important components of the vegetation in wet sites (rainforests, mires, streams) and dry habitats (rock faces, boulders, screes, fellfields), and at environmental extremes where, in the absence of strong competition from vascular plants, they can sometimes dominate the vegetation. In general, bryophytes have adapted a strategy of evolving desiccation tolerance, photosynthesising and growing during moist periods and reducing or suspending metabolism during times of drought (Proctor, 2000).

Many mosses have preferences for particular habitats. Although none are truly marine, some are markedly salt-tolerant, occurring in or above the supralittoral zone, e.g. *Muelleriella crassifolia*, *Grimmia maritima* and *Pottia heimii*. Others, such as *Mitthyridium obtusifolium* and *Taxithelium merrillii* are found in mangrove communities where they are often splashed with brackish water (Windolf, 1989). Some specialists (e.g. *Mittenia plumula*) inhabit extremely deep shade, and a suite of species such as *Encalypta vulgaris*, *Grimmia pulvinata*, *Gigaspermum repens* and *Orthotrichum cupulatum* occur primarily on limestone or on calcareous rocks or soils (Downing *et al.*, 1991, 1995, 1997; Downing, 1992; Downing & Selkirk, 1993; Downing & Coveny, 1995). Others (e.g. *Mielichhoferia mielichhoferiana* and *Scopelophila cataractae*) are abundant on copper-rich soils or those containing high levels of heavy metals, sometimes accumulating them and having potential in geobotanical prospecting and air quality monitoring (Richardson, 1981; Chopra & Kumra, 1988).

In sites where they are abundant, mosses can have a substantial and distinctive influence on the functioning of ecosystems. They contribute to nutrient transfer within ecosystems, as sources of nutrients, and in the translocation and internal redistribution of nutrients. Being poikilohydric, the absence of roots and a cuticle has implications for mineral nutrition as well as water-relations. High water-holding capacity, direct uptake of mineral nutrients from precipitation and low thermal activity, combined with comparative immunity to grazing and slow decomposition resulting in accumulation of humus and peat, can have a greater impact on nutrient cycling, soil temperature and moisture regimes and the range of habitats available to other organisms, than is commonly recognised (Longton, 1984; Jury *et al.*, 1990; Bates, 2000).

Although relatively inconspicuous, mosses, along with other bryophytes and lichens, play a significant role in nutrient cycling and water drainage control in mires, bogs, rainforest and soil crusts. In humid forests, bryophytes often form a carpet on the forest floor, sheath tree trunks, form pendulous curtains from branches or even encrust the surfaces of evergreen leaves. The trapping of rain by epiphytic bryophytes in tropical rainforest has been well documented (e.g. Pócs, 1982; Richards, 1984; Frahm, 1990). Although corticolous epiphytes are more diverse than any other ecological group of bryophytes, only some aspects of their ecology have been studied in detail. Pócs (1982) demonstrated a positive correlation between the biomass of epiphytes and surplus rainfall in forest climates in Africa. Their capacity within rainforests to absorb minute quantities of nutrients from rainwater, exudates from forest leaves and the excrement of insect larvae, and to release these as leachates over time gives bryophytes an important role in the maintenance of the forest. Bates & Bakken (1998) stressed the need to increase research on the bryophyte-rich types of tropical forest where nutrient cycling via terrestrial and epiphytic bryophytes might be far more influential than in

other communities. The mossy covering makes bryophyte-rich forests important watersheds, reducing the damaging effects of torrential rains and regulating the release of water and nutrients slowly over time (Bates, 1992). The diversity of bryophytes in Australian rainforest and eucalypt forest has been discussed by, among others, Ashton & McCrea (1970), Chapman & King (1983), Vitt & Ramsay (1985b), Ramsay *et al.* (1987), Jarman & Fuhrer (1995), Fensham & Streimann (1997), Pharo & Beattie (2002), Ramsay & Cairns (2004) and Turner & Pharo (2005).

As a component of microbiotic soil crusts in semi-arid and arid Australia, bryophytes play an important role in controlling infiltration of water and in preventing erosion (Downing & Selkirk, 1993; Eldridge, 1993; Eldridge *et al.*, 1995; Eldridge & Tozer, 1996, 1997). Mosses assist in increasing insulation at the soil surface, they enhance nutrient cycling, contribute to soil stability, and provide niches for soil invertebrates. Soil function is promoted by the acceleration of physical and chemical weathering, the trapping of windblown sediments, and by the direct contribution to organic matter in the soil. In Antarctic, alpine and semi-arid environments, bryophytes colonise substrata and contribute to consolidation of soil particles on rock surfaces and bare soil thus facilitating colonisation by other plants (Selkirk *et al.*, 1990; Eldridge & Tozer, 1996). In these environments, the trapping of wind-blown particles in moss cushions is more significant in soil development than is the weathering of rock (Longton, 1984).

The evolution of certain physiological attributes had allowed some mosses to metabolise even during extreme drought (Vitt, 1989). The requirement for water for survival and reproduction does not restrict these plants to humid environments because, being poikilohydric, they can utilise water when and where it is available, often being able to withstand long periods of drought and desiccation (Proctor, 1981, 1982, 2000). Some mosses dry out to a water content of 10 per cent or less of their dry weight, and they can tolerate desiccation sometimes for years on end (Proctor, 1984). Physiological adaptations enable rapid recovery, with respiration beginning almost at once on remoistening of dried leaves (Proctor, 1979). Photosynthesis recovers more slowly but the compensation point is reached within minutes (Valanne, 1984). While photosynthesis and respiration can return to normal within 12–24 hours of rewetting, recovery can take longer following prolonged desiccation. Furthermore, the structure of cell organelles (mitochondria, chloroplasts, vacuoles) changes after drying out, but normal structure can be restored within a few hours of wetting (Proctor, 1984).

While physiological adaptations are of considerable importance for survival, behavioural and morphological adaptations can also be influential in protecting mosses from desiccation and high light intensities. The arrangement and stance of moss leaves and their behaviour as they dry out promote water retention. Many xerophytic species have small or long and narrow cells with thick, often papillose walls, dense contents and small vacuoles, e.g. Pottiacaeae, Orthotrichaceae, Grimmiaceae (Bell, 1982). The advantage of thick cell walls for water economy relates to the important role of apoplastic storage and movement of water in mosses (Schofield, 1985). Most members of the Polytrichaceae have rows of lamellae on the leaf surface to increase the surface area for photosynthesis. As they dry out the leaves roll inwards and lie parallel to the stem thus reducing water loss (van Zanten, 1973; Smith, 1982). Hyaline hairpoints, common in Grimmiaceae, Pottiaceae and some other families, and papillae on cell walls in Pottiaceae and Orthotrichaceae, can reduce the rate of evaporation and provide capillaries for rapid wetting and water movement (Edwards, 1984). They also protect the leaves from high light intensities and divert heat from the surface of the plant.

In most mosses the movement of water and nutrients occurs over the surfaces of leaves and stems. These ectohydric species predominate on substrata such as rock and bark and in other nutrient-poor microhabitats (Proctor, 1984). External conduction is facilitated in a variety of ways: spaces among rhizoidal tomentum (*Breutelia* and *Dicranoloma*), paraphyllia (in pleurocarpous mosses), sheathing leaf bases (Calymperaceae and Pottiaceae), interstices between surface papillae (Pottiaceae and Orthotrichaceae), and the lumina of empty, porous or laminal cells (Sphagnaceae and Leucobryaceae). In contrast, endohydric mosses (e.g. many Polytrichales) have comparatively well-developed, internal conducting tissues (Hébant, 1977; Schofield & Hébant, 1984), and these are more common on substrata and in habitats that are more reliably moist and rich in nutrients.

In Australia, some colonising species are adapted for recovery after fire (Duncan & Dalton, 1982), or even after burial in sand-dunes (Moore & Scott, 1979). Indeed, a number of strategies, demonstrated experimentally, are involved in sand-dune recolonisation (Moore & Scott, 1979). These include apical innovations (*Barbula torquata*), monopodial growth (*Tortula antarctica* and *Rosulabryum billarderi*), lateral buds (*Barbula calycina* and *Triquetrella papillata*), persistent rhizoids and primary protonemata (*Barbula torquata*). In many habitats, soil can harbour a diaspore bank that germinates rapidly under suitable conditions (Selkirk, 1984; Bergstrom & Selkirk, 1987).

A significant contribution to a greater understanding of the ecology of mosses has been the recognition of 'life forms' (Gimingham & Birse, 1957; Magdefrau, 1982; Richards, 1984), and the identification of a number of 'life strategies' as proposed by During (1979). The life forms and life strategies of mosses relate to gametophyte longevity, reproductive effort, spore size and other attributes (Longton, 1988).

Life forms

Life form is an ecological concept embracing structural characters, the aggregation of individuals and their relationship to the substratum. Acrocarpy is favoured in unstable or xerophytic habitats where taxa often have ephemeral gametophores (e.g. *Pottia*, *Phascum*, *Eccremidium*, *Goniomitrium*, *Gigaspermum* and *Bryobartramia*), prolific sporophyte production, large spores (often 100 µm in diameter), persistent protonemata, small gametophores, and capsules that are often cleistocarpous and gymnostomous, being immersed on a shortened seta. In contrast, pleurocarpy is generally favoured in sheltered, often forested habitats.

Turfs

Turfs can be short or tall, with short turfs predominant on open, mineral soils (*Ceratodon*, *Barbula* and *Ditrichum*) and tall turfs (*Dicranoloma*, *Campylopus*, *Pyrrhobryum* and much of the family Polytrichaceae) in grassland or as ground cover in temperate forest.

Cushions

Cushions (e.g. of *Andreaea*, *Orthotrichum*, *Tortula* and *Grimmia*) occur in exposed habitats such as bare rock or as epiphytes on bark. Many are xerophytic and have short, straight or curved thick setae, oblong to ovoid, sometimes strongly ribbed capsules, often with large calyptrae (*Schlotheimia*) and a peristome that is reduced or absent (e.g. *Macromitrium*), while others are emergent from long perichaetial leaves (*Eucamptodon* and *Calyptopogon*; Vitt, 1981).

Mats and wefts

Mats (e.g. *Hypnum*) and wefts (e.g. *Thuidium*) are usually pleurocarpous mosses with a prostrate growth form. They are most common in mesophytic, stable ecosystems with broad niche overlap and long growing seasons (Buck & Vitt, 1986).

Pendants, dendroids, tails and fans

These are also pleurocarps restricted to very moist forests. Pendants (Meteoriaceae) occur on branches and trunks, while tails, fans and fan-like forms (Neckeraceae, Pterobryaceae) are found on tree trunks and rocks in sheltered places. Dendroids (Hypnodendraceae, Hypopterygiaceae, *Camptochaete*) are confined to the forest floor and grow on rocks, tree bases or soil on stream banks (Frey & Beever, 1995).

Life strategies

Life strategies (During, 1979) are concerned primarily with the life histories associated with mosses in particular environments.

Annual shuttle species are often present in unstable habitats; for example, some species of *Funaria* have ephemeral gametophores.

Perennial shuttle species have xerophytic gametophores and large diaspores (During & van Tooren, 1987; Longton, 1988), occupy habitats that remain available for long periods and recur predictably within particular ecosystems.

Fugitives are tolerant of severe desiccation, can produce abundant spores and are either annual or biennial (e.g. *Funaria hygrometrica*).

Colonists are primarily turfs and are either tall (e.g. *Dawsonia* and *Pogonatum*) or short (e.g. *Grimmia* and *Schistidium*). They frequently have splash cups to enable sperm to travel farther than would otherwise be possible. In exposed habitats, colonist and fugitive species frequently produce large numbers of diaspores that are dispersed by rainwash or wind.

Perennial stayers predominate in hot or cold, arid environments or as epiphytes with xerophytic gametophytes. These have small spores (less than 20 µm in diameter), long setae and other features that promote dispersal. Examples include many Pottiaceae (species of *Tortula* and *Barbula*).

Epiphytes predominate in rainforest and are often vertically stratified, some also being phorophyte-specific, e.g. *Calomnion* on tree ferns. Many species that occur in the canopy have exceptionally high light tolerance. Epiphytes also exhibit morphological, reproductive, physiological and biochemical specialisations (see Smith, 1982; Richards, 1984; Chopra & Bhatla, 1990) that seem to have evolved comparatively recently (e.g. in *Macromitrium*; Vitt & Ramsay, 1985b). Epiphylls comprise a subgroup that inhabit the surfaces of living leaves.

While ecological studies of mosses have concentrated on adaptations of the gametophyte, the importance of the sporophyte should not be overlooked. Successful spore dispersal is essential for evolutionary progress, and the limited size of the sporophyte and its partial dependence on the gametophyte are, in the long term, a great disadvantage. Sporophytes in fugitive and colonist species contribute more to their own nutrition than do sporophytes in species with other life strategies. Increased reliance on translocation from the gametophore is typical of robust, long-lived, perennial species as well as the more ephemeral, annual shuttle species with simplified capsules (Longton, 1984). Correlations can be observed between, for example, seta length, capsule width, peristome reduction, spore size, length of life history, and habitat. Thus, for example, erect capsules predominate in epiphytic or saxicolous habitats, while species on moist forest floors often have elongate, straight setae and curved, horizontal or pendent capsules that are smooth, cylindrical and have a well-developed peristome. Because this same set of characteristics can occur in related or completely unrelated taxa in the same environment, these are considered to have adaptive value (Vitt, 1981; Shaw & Robinson, 1984).

Distribution

Factors determining the distribution of mosses include the availability of water and suitable conditions for growth and reproduction. Modern distributions have been influenced by past climates, habitat history and the method of dispersal of the species. For species to spread by vegetative, horizontal growth alone, a continuum of suitable habitats and climatic conditions over space and time would be required. Scott (1988) estimated that an acrocarpous cushion type might require one million years to spread 10 km, while a pleurocarp might move ten times farther in the same time. However, distribution of most mosses is not determined by growth alone but by dispersal of spores or vegetative propagules. While fragments and some larger diaspores might be distributed by short-range dispersal, the capacity for smaller diaspores to survive long-range dispersal depends on their vulnerability to desiccation and low temperatures (van Zanten, 1978).

The successful transition from diaspore to new colony requires a suitable niche and the ability to establish in competition with existing vegetation, or to regenerate vegetation after natural disturbances (van Zanten & Pócs, 1981). Spread of a species depends on colony's growth rate and macroclimatic and micro-scale moisture conditions. The estimated primary colony expansion and establishment period can take as long as 30–40 years (Vitt, 1989).

Evidence that mosses are distributed over long distances has been clearly demonstrated in the vegetation of isolated Subantarctic islands such as Macquarie Is. and Heard Is. (Bergstrom & Seppelt, 1988; Selkirk *et al.*, 1990). Short-distance dispersal tends to be most influential among aggressive pioneers of inhospitable areas where competition is minimal, or in non-aggressive species if the vegetation is not saturated (van Zanten & Pócs, 1981).

In Australia, patterns of distribution, determined by both macro- and micro-climate, frequently correspond to gross vegetation types, e.g. rainforest and arid zone vegetation. Factors of particular importance include rainfall and humidity, and many families of pleurocarps (e.g. Meteoriaceae, Sematophyllaceae, Thuidiaceae and Hypnaceae) predominate in moist forests in the eastern coastal regions of the country. Temperate species are distributed widely across southern latitudes from the south-west of Western Australia to coastal South Australia, Tasmania, Victoria, the Australian Capital Territory and southern and eastern New South Wales (Scott & Stone, 1976). Alpine and subalpine species are confined to the Southern Tablelands of New South Wales, parts of the Australian Capital Territory, north-eastern Victoria and Tasmania (Ramsay *et al.*, 1986). Subtropical and tropical species occur as far south as the central coast of New South Wales and north into Queensland, while tropical species occur across northern Australia with the greatest diversity in north-eastern Queensland (Ramsay & Cairns, 2004). The high peaks in this area, Mt Bartle Frere, Mt Bellenden Ker, Thornton Peak and Mt Lewis, have a distinctive bryoflora and include endemics such as *Macromitrium dielsii*, *Clastobryum dimorphum*, *Touwia laticostata* and *Buxbaumia thorsborneae*. Arid and semi-arid species occur west of the Great Dividing Range and in the drier areas of the Northern Territory, South Australia and Western Australia (Catcheside, 1980; Ramsay, 1984; Stoneburner *et al.*, 1993).

The mountain ranges, tablelands and moist forests near the east coast of Australia support a considerable diversity of mosses in contrast to the more arid regions to the west of the Great Dividing Range. Thus, at least 60 per cent of Queensland mosses occur in the wet-tropical forests of the north-east (Ramsay & Schofield, 1987; Ramsay, 1988b; Ramsay & Cairns, 2004). Some are endemic, and the remainder have strong affinities with the bryofloras of New Guinea, New Caledonia or Malesia. The interesting mix of subtropical and temperate species in the *Nothofagus moorei* forests of the border ranges between New South Wales and Queensland represents a rather different bryoflora, while the lowland monsoon forests of the Northern Territory, the north of Western Australia and north Queensland contain different suites of species (e.g. Catcheside & Stone, 1988; Stoneburner *et al.*, 1993).

The cooler and more moist habitats of southern New South Wales, Victoria and Tasmania support a diverse temperate moss flora, and the mountains ranges have distinct alpine and subalpine elements (Ramsay *et al.*, 1986). South-eastern Australian moss floras are more similar to those of New Zealand and Subantarctic Macquarie Is. (Scott & Stone, 1976; Ratkowsky & Ratkowsky, 1982; Ramsay *et al.*, 1986; Selkirk *et al.*, 1990; Seppelt 2004). Of the 54 alpine mosses in Tasmania, 44 also occur in Macquarie Is., 34 in mainland Australia and 38 in New Zealand (Ramsay *et al*., 1986).

Based on published checklists and more recent data (e.g. Streimann & Klazenga, 2002; Klazenga, 2005) about 26% of the moss species in Australia are thought to be endemic. While endemism was previously considered to be most pronounced in the coastal and montane rainforests of north-eastern Queensland (from south of Cooktown to just north of Townsville), a recent study has shown this to have been exaggerated, with the actual level of endemism in that area being only about 7 per cent of the moss flora (Ramsay & Cairns, 2004). Although the total number of mosses recorded from the Northern Territory is comparatively low (113 taxa), six are thought to be endemic. New South Wales has a higher degree of endemism (70 species, or 12 per cent of the flora), Victoria and Tasmania have significant numbers of endemics (18 and 26 species, respectively), while Western Australia has three species and South Australia does not have any endemic species.

Inland of the Great Dividing Range, moss diversity decreases markedly with increasing aridity (Ramsay, 1984; Stoneburner *et al*., 1993). Thus, for example, only one of the 21 species of *Macromitrium* (*M. archeri*) in Australia occurs in Western Australia. However, 70 per cent of Western Australian mosses are also found in South Australia, 67 per cent in

New South Wales and 46 per cent in Queensland (Stoneburner *et al.*, 1993). In the semi-arid areas of Victoria, Western Australia and South Australia the most diverse families are the Pottiaceae, Dicranaceae, Bryaceae and Fissidentaceae (Catcheside, 1980, 1982; Stoneburner *et al.*, 1993; Streimann & Klazenga, 2002). Few pleurocarpous taxa occur in these drier areas (only 20 species recorded from Western Australia and 31 from South Australia), but ephemeral, acrocarpous forms are well represented. The distribution of mosses in Western Australia demonstrates a north-south disparity, with 147 species in the south-west and only 29 in the Kimberley Region in the north. While exploration and collecting has been most intensive in the south-west, the low diversity of mosses in the north is unequivocal (G.A.M.Scott, pers. comm; H.Streimann, pers. comm.). The paucity of moss species and low levels of endemism in the south-west of Western Australia is in marked contrast to the very high diversity and endemism of angiosperms in the same area (75–80 per cent; Hopper, 1979).

Surprisingly, Polytrichopsida are absent from Western Australia and the Northern Territory although suitable habitats are available. These mosses are common in the eastern States and in New Zealand, and include many weedy species of roadsides and other disturbed sites.

Mosses are rather poorly represented in ‘typical’ Australian eucalypt forests (see Ashton, 1986; Meagher, 1996). In contrast, diversity and abundance are greatest in the more ancient rainforest elements such as the *Nothofagus* and podocarp forests of southern Australia, the montane rainforest along the Great Dividing Range to northern Queensland (Catcheside, 1982; Ramsay, 1984, 1988b; Ramsay *et al.*, 1986; Ramsay & Cairns; 2004) and in Tasmania (Dalton *et al*., 1991; Jarman & Fuhrer, 1995). Species of *Papillaria* and *Macromitrium* occur from Tasmania to north-eastern Queensland, while some families (e.g. Calymperaceae and Sematophyllaceae) are primarily tropical in origin and are diverse only in north-eastern Queensland, being rather poorly represented elsewhere in Australia. Primary colonisers such as the Fissidentaceae, Bryaceae, Ditrichaceae, Funariaceae and Pottiaceae are present throughout Australia, although species composition varies between different climatic regions. Temperate mosses such as *Bryum s. lat.* and *Tortula* tend to be diverse across southern-temperate Australia but have fewer species in the tropics. However, in the genus *Rosulabryum*, with 14 Australian species, ten occur in north-eastern Queensland and five are endemic to Australia.

Biogeography

The historical and biological factors determining patterns of distribution in bryophytes are rather similar to those that influence vascular plants. However, bryophytes, with their distinctive propagules and long-distance dispersal tend to exhibit broader geographical ranges (van Zanten & Pócs, 1981; Schuster, 1983; Schofield, 1985, 1992).

Hill *et al.* (1999) and Crisp *et al.* (1999) described the tectonic events that shaped the origin and evolution of the Australian angiosperm flora. While mosses were probably already diverse and widespread before the separation of Gondwana and Laurasia, climatic changes and subsequent dry periods fragmented and diversified the existing bryoflora, subjecting it to intense selective pressures with only those species in protected niches surviving. Between the Cretaceous and Mesozoic, selection favoured terrestrial, drought-tolerant genotypes. During the Tertiary, with the rise of the angiosperms, microclimatic and microedaphic shifts opened up forest niches and led to an increase in the diversity of bryophytes, especially epiphytes (Vitt, 1984).

The first detailed analysis of floristic regions for mosses on a global scale was that of Herzog (1926) who delimited six bryogeographical kingdoms which were later mapped and further described by Miller (1982). Wijk *et al*. (1959–1969) recognised 20 floristic regions that have been widely accepted, although Tan & Pócs (2000) suggested that some revision of boundaries is required. Schofield (1992) provided an interpretation of the six Herzog kingdoms: Holarctic, Palaeotropical, Neotropical, Cape or South African, Holantarctic and Australian, the Australian bryoflora having elements of the last two.

The Holantarctic Kingdom developed from the floras of widely separated elements of Gondwana. Floristic affinities are greatest between those fragments that have had most

recent direct connections, while floristic richness is most pronounced in those areas with the greatest time of isolation from other floras combined with the greatest niche range (Schofield, 1992). Intercontinental similarities at the species level are most likely the result of long-distance dispersal (van Zanten & Pócs, 1981). Examples of circum-Subantarctic species are especially common in genera such as *Hypnum* (Ando, 1972, 1982), *Campylopus* (Frahm, 1987, 1994) and *Bryum s. lat.* (Ochi, 1982). Floristic affinities between Australia and southern Africa are demonstrated by mosses such as *Ischyrodon lepturus*, *Catagonium nitens*, *Eccremidium exiguum* and *Bryobartramia novaevalesiae* (Scott & Stone, 1976), all of which occur in the drier areas of Victoria, South Australia and Western Australia. By contrast, genera such as *Catagonium*, *Cyrtopus*, *Goniobryum*, *Ptychomnion*, *Weymouthia* and species such as *Dicranoloma menziesii*, *Hypnum chrysogaster*, *Goniobryum subbasilare*, *Campylopus chilensis*, *C. laxoventralis* and *C. modestus* represent links between Australasia and South America. The cool, mesic climate of southern Gondwana provided a refugium for austral bryophytes, and remnants of the Gondwanan bryoflora persist today in high southern latitudes (Miller, 1982; Vitt, 1982b, 1984). Fifty-six species are common to the alpine areas of Australia and New Zealand, but only six are shared between the alpine areas of Australia and Papua New Guinea (Ramsay *et al.*, 1986). Among the species confined to Australia and New Zealand are *Camptochaete arbuscula*, *Cryphaea exannulata*, *Fallaciella gracilis*, *Meesia muelleri*, *Mittenia plumula*, *Rhaphidorrhynchium amoenum*, *Sematophyllum homomallum* and *Tridontium tasmanicum*.

The Australian Kingdom, which occupies most of the continent, lies between the Holantarctic in the south and the Palaeotropical in the north (Schofield, 1992). In the Tertiary, when sea levels were higher, much of Australia was an archipelago of islands, and each of these islands, now connected by dry land, became a reservoir of endemic angiosperm species that had evolved during the isolation. This Kingdom encompasses areas of great climatic diversity, from the wet and humid coastal regions and tablelands along the Great Dividing Range, and alpine and subalpine areas in the south-east, to the arid and semi-arid centre or Eremaean Zone occupying more than one-third of the land area of the continent. Schodde (1989) proposed five biotic regions based on evidence from biogeographical studies of the flora and fauna (see Groves, 1999, p. 323). More than half of Australia experiences seasonal or continuous aridity (Hill *et al.*, 1999). Bryophytes are poorly represented in modern Australian *Eucalyptus* forests, but they are diverse in rainforest with a long geological history. Palaeotropical elements are well represented in northern Australia, and a significant Gondwanan element, including the Hypnodendraceae, Leptostomaceae and some species of *Campylopus*, *Macromitrium* and *Fissidens*, is also present in temperate to tropical habitats.

Tan & Pócs (2000) have a broader view of the Australian region, and they include Australia, New Zealand, New Caledonia and offshore islands in their Australasian zone. With the exception of the Gondwanan element, the strongest affinities of the Australian bryoflora are with the Paleotropical Kingdom (Schofield, 1992) which includes the Indomalayan area, western Melanesia and the oceanic islands of the western Pacific including New Caledonia. Tan & Pócs (2000) defined Malesia as comprising a long chain of peninsular and island countries (Malaysia, Indonesia, the Philippines, Brunei and Papua New Guinea). Moreover, they noted its unique geological history following the collision of the Sahul, Sunda and Australian plates during the mid-Tertiary. Several of the islands, e.g. Sulawesi and the Philippine archipelago, are composite in origin, being the accretion of Laurasian and Gondwanan elements (Hall & Holloway, 1998). Thus, floras that were originally dissimilar have subsequently become integrated (Tan & Pócs, 2000), so that the modern lowland bryoflora is mainly Asiatic, while the montane and eastern Malesian floras have a strong representation of Australian elements.

Parts of the northern Australian bryoflora appears to be of recent Asian-Malesian derivation. While Australia and Papua New Guinea share 50–60 per cent of genera (Ramsay *et al.*, 1986), affinities at the species level are much lower (about 10 species; Hyvönen, 1989). A few species of Australasian affinity extend into Malesia (*Hampeella pallens* and *Dicranoloma billardierei*), some are confined to southern Malesia (e.g. *Thuidium sparsum* and *Sclerodontium pallidum*), while *Glyphothecium sciuroides* and the genus *Leptostomum*

extend through temperate rainforest zones of Australasia and South America. Species of Australian origin also occur in the tropical montane forests of Malesia and Sri Lanka with a disjunction in eastern Australia suggesting fragmentation of a previously continuous distribution caused by the increasing aridity of Australia (Touw, 1992). In western Melanesia 35 taxa (mainly Calymperaceae and Meteoriaceae) are shared with Australia, Asia and Oceania and 16 are shared with Asia and Australia (Hyvönen, 1989). Pippo & Koponen (1997) have discussed the affinities of Australian moss species within western Melanesia.

Northern Hemisphere families, such as Hypnaceae and Brachytheciaceae, are poorly represented in Australia. Although Schuster (1983) suggested that the c. 200 million years of Gondwanan isolation resulted in a high degree of endemism at family and genus level in the Southern Hemisphere, endemism of this type is actually low in Australia, the small number of endemic genera including *Bryostreimannia*, *Calymperastrum*, *Mesochaete*, *Stoneobryum* and *Touwia*.

Biogeographical disjunctions within Australia include those between the eastern-coastal region and the rest of the country and between northern and southern latitudes. While some disjunctions are almost complete, there are noticeable areas of overlap between, for example, subtropical and temperate floras of eastern New South Wales. Here, fragments and derivatives of the Gondwanan flora have been enriched at high elevations by Holarctic and Holantarctic elements that have arrived by dispersal in the last 2–3 million years. Supportive evidence is found in Gondwanan groups with restricted Southern Hemisphere distributions (e.g. Hypnodendraceae, Orthotrichaceae, Calomniaceae and some members of the Sematophyllaceae) and the absence of large numbers of Laurasia-derived Hypnobryales (Vitt, 1990).

Primarily pantropical families present in Australia include the Calymperaceae, Sematophyllaceae, Meteoriaceae, Pterobryaceae and Racopilaceae. Pantropical and palaeo-tropical floristic elements are strongly represented in northern Australia, especially north-eastern Queensland (Ramsay & Cairns, 2004). This diversity is well documented for families such as the Sematophyllaceae (Ramsay *et al.*, 2004), Bryaceae (Eddy, 1996; Spence & Ramsay, 1996; Spence & Ramsay, this volume). The Calymperaceae is represented in north-eastern Australia by 42 species, most of which are palaeotropical (Eddy, 1996; Reese & Stone, 1995).

Apart from the bryogeographical relationships already discussed, Australian mosses include some that are cosmopolitan or bipolar in their distributions. Examples of widespread species include *Brachythecium rutabulum*, *Ceratodon purpureus*, *Bryum argenteum*, *Encalypta vulgaris*, *Grimmia pulvinata*, *Leptobryum pyriforme* and *Polytrichum juniperinum*. Bipolar mosses present in Australia include *Pottia heimii*, *P. truncata*, *Orthodontium lineare*, *Drepanocladus uncinatus* and *Aulacomnium palustre* (Schofield, 1974).

The Australian bryoflora includes taxa with diverse histories and potentials, and those with ancient ancestors as well as comparatively recent colonisers. Knowledge of the current distribution of mosses will improve as taxonomic and ecological studies continue, but “the database for bryogeography is limited, and will remain so, because of the destruction of flora and habitats by human activity and the paucity of fossil evidence, even for relatively recent time” (Schofield, 1992).

Origin and Evolution of Mosses

There is evidence to support the evolution of terrestrial green plants from aquatic ancestors that possessed an alternation of sporophyte and gametophyte generations (Smith, 1986; Goffinet, 2000). Success in the terrestrial environment required the development of physiological and morphological adaptations to prevent desiccation as well as mechanisms for the formation and protection of the diploid embryo. Although all land plants possess the heteromorphic alternation of gametophyte and sporophyte generations, two trends have evolved based on the location and ontogeny of the embryo initial following fertilisation.

In bryophytes, the sporophyte is wholly or partially dependent on the gametophyte for nutrition, and it remains attached to the archegonial venter for a long period. In contrast, the sporophyte of ferns, fern allies, gymnosperms and angiosperms is both independent and photosynthetic.

Bryophytes and green algae have similar photosynthetic pigments, cell wall components, starch as a food reserve and flagellar characteristics. A closer affinity of bryophytes to the vascular plants rather than to the algae is supported by the shared characteristics of conducting tissue elements, stomata, cell division with a spindle at mitosis, multicellular sex organs, cutinised and ornamented trilete spores with sporopollenin in the wall, ultrastructural features (Smith, 1986), the occurrence of lignin-like and flavonoid compounds (Mues, 1990), the close relationship between gametophyte and sporophyte, and the absence of a pyrenoid (except in the hornworts).

An appreciation of the role of bryophytes is critical to an assessment of evolution in the terrestrial environment (Mishler & Churchill, 1985). The fossil record and phylogenetic studies indicate that the major groups of bryophytes are very ancient and probably originated near the time of the earliest land plants (Goffinet, 2000; Jordon, this volume).

The oldest known fossil land plants share some common features with bryophytes. This suggests that the various bryophyte groups may have originated from a diverse gene pool at a level sufficient to achieve partial transmigration to land (Miller, 1979; Crandall-Stotler, 1986; Smith, 1986; Kendrick & Crane, 1991; Mishler *et al.*, 1992). The literature on palaeo-climatology and plate tectonics also supports the notion that some ancestral bryophytes might have arisen with other land-plants and constituted one of several largely unrelated archegoniate lines. Adaptation to similar pressures imposed by the gametophyte-dominated, heteromorphic, archegoniate life history (Crandall-Stotler, 1984) would have been necessary for all bryophytes. Cladistic analyses, morphological, molecular and genetic studies (Mishler & Churchill, 1984, 1985; Mishler, 1986; Mishler *et al.*, 1992; Goffinet, 2000) support a monophyletic origin for land plants, a position hotly debated and not necessarily supported by all (e.g. Waters *et al.*, 1992), with the mosses being a monophyletic sister group to vascular plants and the liverworts a sister group of a moss-vascular plant lineage. Crosby (1980), Mishler & Churchill (1984, 1985) and Crandall-Stotler (1986) considered the bryophytes to represent several lines of evolution separate from vascular plants, although they may share common ancestors since they have similar life cycles and structural organisation of the gametophyte and sporophyte. Recent phylogenetic reconstructions of the relationships support the hypothesis that hornworts are the most basal group with mosses and liverworts forming a monophyletic sister clade to the vascular plants (Goffinet, 2000).

While bryophytes appear anatomically simple when compared with vascular plants, they are not necessarily morphologically primitive (Stoneburner, 1990). Many are uniquely suited to survival at environmental extremes (Schofield, 1985) and, indeed, the complex biochemical nature of mosses (Suire & Asakawa, 1979; Asakawa, 1986; Mues, 1990, 2000), their physiological responses to the environment, levels of genetic variation (Stoneburner *et al.*, 1991; Goffinet, 2000; Cove, 2000) and cytological complexity (Smith, 1978, 1986; Newton, 1986) do not suggest primitiveness.

Evolutionary trends in mosses

Although all mosses share the gametophytic features of an apical cell with 3 cutting faces, leaves originating from stem segments derived from this cell and differentiation of separate leaves, sporophytic attributes suggest distinct evolutionary lines. While trends in the evolution of mosses are reflected in both the gametophyte and sporophyte (Vitt, 1984; Schofield, 1985), it is the development of the capsule and the structure of the mature peristome that best demonstrates relationships.

There are two main evolutionary trends in evidence in the origin and development of the moss peristome. Based on the primary architecture of the teeth, peristomes are either nematodontous or arthrodontous. The former occur in Takakiopsida (not in Australia), Andreaeopsida, Andreaeobryopsida (not in Australia), Sphagnopsida, Polytrichopsida and

(?)Oedopodiopsida (not in Australia). Inferences from morphological data and the nuclear and chloroplast genomes have led to an evolutionary scheme in which *Takakia* and *Sphagnum* form a weakly supported basal lineage, followed by the Andreaeopsida and Andreaeobryopsida and, finally, those mosses with a cylindrical columella. However, none of the ambiguities pertaining to the early diversification of mosses have been clarified, and reconstruction of ancient evolutionary events is still problematic (Goffinet & Buck, 2004).

Nematodontous peristomes

Prior to the discovery of male plants and sporophytes (Smith, 1990), *Takakia* was regarded as a hepatic. However, Hedderson *et al.* (1996, 1998) provided the molecular evidence in support of *Takakia* belonging to the mosses (Class Takakiopsida). Capsules dehisce occurs along a single longitudinal spiral line.

In the Sphagnopsida, the gametophore is highly specialised, but the protonema is simple. Moreover, the unistratose leaves are exceptionally distinctive, with the differentiation of dead hyaline porous cells and living chlorophyllose cells. The unusual branching system with fascicles of lateral branches, the nature of the perigonial branches and the pseudopodium associated with growth of the sporophyte are a morphological rather than a physiological adaptation to drought (Pujos, 1992). The sporophyte has a columella overarched by a specialised sporogenous layer, it lacks an operculum, and there is an explosive dehiscence of the capsule. The recently described Tasmanian moss *Ambuchanania leucobryoides* (Sphagnopsida, Order Ambuchananiales) is highly distinctive in terms of its morphology, and it occupies very different habitat to *Sphagnum* species (Seppelt, this volume). Molecular studies by Shaw (2000) resolved *Ambuchanania* as sister to the remainder of Sphagnopsida.

In the Andreaeopsida, leaf arrangement and structure and the gametangia are comparatively unspecialised; these mosses are characterised by the dehiscence of the capsule by one or more longitudinal sutures as a means of exposing most of the spores for dispersal. Within the Andreaeopsida *s. lat.*, evolution has followed two lines, one leading to the present class Andreaeaopsida and the genus *Andreaea*, and the other to the distinct genus *Andreaeobryum* in the new class Andreaeaobrypsida (Goffinet & Buck, 2004).

A significant contribution of molecular research to our understanding of moss evolution has been the recognition of *Oedipodium* as the sister group to the peristomate mosses. Goffinet & Buck (2004) highlighted its significance by placing it in the monotypic Class Oedipodiopsida. *Oedipodium* lacks a peristome, and whether it is pleisomorphic or the result of secondary loss remains unclear. Peristomate mosses and *Oedipodium* share a cylindrical columella as well as protonemal disc-branch initials (Newton *et al.*, 2000).

There is considerable specialisation in the gametophore of the Class Polytrichopsida, with a well-developed and elaborate water-conducting system in the gametophyte and sporophyte (Hébant, 1977, 1979), sheathing leaf bases, rows of photosynthetic lamellae parallel to the costa on the adaxial surface of the leaves and underground ‘rhizomes’. Differentiation of the conducting system appears to have enabled some tall, free-standing gametophores to reach up to 60 cm or more in height. Species are usually dioicous, and male plants possess a ‘splash-cup’ perigonium to enhance wider distribution of sperm to the tall perichaetium-bearing gametophores, and produce enormous quantities of exceptionally minute spores (Ingold, 1959). In the Polytrichaceae the peristome has 16, 32, or 64 multicellular teeth, while in *Polytrichum* 3 or 4 cell layers contribute to small teeth arranged in a single circle. In *Dawsonia*, teeth are elongate, bristle-like and arranged in several irregular circles, being derived from more than 6 concentric cell rows. A phylogenetic reconstruction of the family Polytrichaceae was provided by Hyvönen *et al.* (1998, 2004). Support for the monophyly of the family is drawn primarily from the chloroplast gene rbcL, while genetic data from DNA give ambiguous support for generic relationships.

The gametophyte of Class Tetraphidopsida, with only five species, shares many features with the Bryopsida. However, it differs in the absence of air spaces in the capsule, a character state shared with the other basal lineages such as *Takakia, Sphagnum* and *Andreaea* (Goffinet

et al., 2004a). The multicellular structure of the four peristome teeth places it closer to the nematodontous type of the Polytrichales (Edwards, 1984). Preliminary molecular studies have been unable to resolve the relationships between the Polytrichales and Tetraphidales (Goffinet & Buck, 2004).

Further research is essential to determine the significance of the nematodontous peristome in the evolution of the arthrodontous teeth typical of the Class Bryopsida (*sensu* Buck & Goffinet, 2000). The Bryopsida, with at least 12,000 species, exhibits characters that include dorsiventrally flattened gametophores, multiple costae, elaboration of leaf cell surfaces, diversification of cells in the alar region, production of a range of gemmae and other asexual propagules, elaboration of branching systems, diversity of growth forms, acrocarpy and pleurocarpy, specialisation of perichaetia and perigonia and anisospory. Major evolutionary trends in the gametophyte include differences in life form, growth form, branching pattern and perichaetial position.

Mitten (1859) first recognised the phylogenetic significance of acrocarpy and pleurocarpy. However, the distinction is not always clear-cut, and some acrocarpous groups appear to have prostrate species with laterally displaced branching, e.g. *Macromitrium* and *Schlotheimia* in the Orthotrichaceae, sometimes called “pseudopleurocarpous” (Vitt, 1984), while *Cinclidotus* (Cinclidotaceae) has been described as pseudopleurocarpous (Proctor & Smith, 1995) or cladocarpous (Smith, 1978). Cladocarpy has often been defined as a form of pleurocarpy (Frey, 1971; Magill, 1990; Mishler & De Luna, 1991).

Different interpretations of perichaetial position have resulted in a reassessment of some families and their genera, e.g. Rhizogoniaceae and Spiridentaceae (Buck & Vitt, 1986; Koponen, 1988), Hedwigiaceae (Vitt & Buck, 1984; Buck & Vitt, 1986; Hedenäs, 1994; De Luna, 1995). Using more precise definitions, La Farge-England (1996) demonstrated that cladocarpy is widespread in acrocarpous lineages and that the distribution of perichaetial position in 14 major clades of the Bryopsida divides them into three basic patterns: acrocarpous-cladocarpous, cladocarpous-pleurocarpous and pleurocarpous lineages. The amended definitions of perichaetial position present a framework to enable a more rigorous assessment of the structural organisation of mosses and, consequently, more informative insights into evolutionary relationships (La Farge-England, 1996).

Arthrodontous peristomes

In arthrodontous peristomes, teeth consist of cell-wall remnants rather than whole cells. The haplolepidous, or *Dicranum*-type has the endostome segments composed of a single column of cell plates on their outer surface. Diplolepidous peristomes have two columns of dorsal plates on the outer teeth and usually two rings of teeth. In the two diplolepidous subgroups, the exostome teeth in the outer ring can either be opposite the segments of the inner ring or alternate with them (Vitt, 1981, 1984; Shaw & Robinson, 1984; Buck & Goffinet, 2000).

Goffinet & Buck (2004) recognised several subclasses of Bryopsida. Among these, the Funariidae (with a diplolepidous-opposite peristome) includes four families, Funariaceae, Gigaspermaceae, Disceliaceae and Encalyptaceae. The Dicranidae, with a haplolepidous peristome, comprises 24 families including the speciose Grimmiaceae, Archidiaceae, Fissidentaceae, Calymperaceae, Ditrichaceae and Pottiaceae. The Bryidae includes 15 families with acrocarpous and pleurocarpous forms and a diplolepidous peristome. Significant acrocarpous families in the Australian bryoflora include Orthotrichaceae, Bartramiaceae, Bryaceae and Leptostomaceae, with Hypnodendraceae, Rhizogoniaceae, Pterobryellaceae and Racopilaceae among the pleurocarps. A fourth subclass, the Hypnidae, includes 50 families of pleurocarpous forms with diplolepidous-alternate peristomes. One order, the Hypnales, includes many significant families in the Australian flora, e.g. Amblystegiaceae, Sematophyllaceae, Meteoriaceae, Hypnaceae, Cryphaeaceae, Pterobryaceae, Neckeraceae and Lembophyllaceae.

Because of certain unique attributes, two subclasses of the Bryopsida (*sensu* Goffinet & Buck, 2004), the Buxbaumiidae and Diphysciideae, are now recognised as separate although they share a unique peristomial architecture (Edwards, 1984) with the inner peristome

consisting of a high, pleated membrane. In *Buxbaumia*, the reduction of the gametophyte is so pronounced that it consists of a few perichaetial leaves surrounding one or two archegonia in the female, or a perigonium with a single antheridium surrounded by a unistratose sheath in the male. In the Buxbaumiideae the sporophyte is a distinctive shape with the amphithecial layer double that of *Diphyscium*. In the peristome of *Buxbaumia* the walls of one or two outer layers of cells may be thickened and partially resorbed, and thus they form two rows of teeth, even if the outermost row is rudimentary and remains partially attached to the capsule wall. In *Diphyscium*, the gametophores are reduced with ±multistratose, chlorophyllose leaves, and there is little if any differentiation of the stem. The outer peristome is composed of a single row of teeth fused to the inner membrane. The cells surrounding the outer peristome are entire and markedly thickened. The peristome is reminiscent of the nematodontous type, but most of the circles of teeth are remnants of cell walls *not* whole cells, hence they are apparently arthrodontous (Shaw *et al.*, 1987).

Distinctive features of the Order Archidiales, now placed in Subclass Dicranidae (Goffinet & Buck, 2004) although its affinities remain ambiguous, include the multilayered intine (formed by different orientations of intine microfibrils; Brown & Lemmon, 1985) not known to occur in the spore cells of any other moss except *Sphagnum*. Other characteristics include the genesis of cell layers in the embryonic sporophyte with two columns of endothecial cells (instead of four), bilateral instead of radial symmetry of the sporophyte, a dome-shaped spore sac and intercellular airspaces, the absence of an inner spore sac, rudimentary columella, small numbers of sporocytes (4–12), the largest spores known in mosses with thick laminated intine (Stone, 1987) and the absence of a seta and peristome. In some species the protonema is persistent.

Vitt (1984) placed Calomniaceae in the Order Tetraphidales (Polytrichopsida), but in his later revision of *Calomnion* (Vitt, 1995) he suggested that a possible close relationship to Rhizogoniaceae (Bryopsida, Bryidae). The absence of a peristome in Calomniaceae creates uncertainty as to its affinities, but chromosome data tend to support placement in or near the Rhizogoniaceae (Ramsay, 1992; Goffinet & Buck, 2004).

An important trend in the evolution of the gametophyte leads to structural reduction, with the greatest degree of specialisation being the production of multicellular spores (e.g. in some Orthotrichaceae), or massive spores consisting of pregerminated protonemata (e.g. in Dicnemonaceae). Some species with specialised protonemata also show ecological specialisation (e.g. *Mittenia plumula* often found in caves, or *Calomnion complanatum* epiphytic on tree ferns). Size, physiological adaptations and morphological diversity, while restricted by the absence of lignified vascular tissue and the development of roots, have nevertheless led to a great diversification of species.

Evolutionary trends in the sporophyte include reduction in the number of cell layers involved in the production of the peristome and the loss of the exostome, endostome or both. Determination of directions of evolution should be made on consideration of character correlations (Vitt, 1984). Thus, for example, the acrocarpous growth form is most prevalent in taxa with the diplolepidous-opposite and haplolepidous peristomes, while cladocarpous and pleurocarpous growth forms occur in all major lineages and are an evolutionary adaptation to specialised substrata and environmental situations (Vitt, 1984). In mosses of considerable physical length, structural support is given by water; or alternatively they are prostrate or pendant. In some epiphytic mosses, the stems have supportive fibre-like stereids but lack an elaborate conducting system. In spite of the considerable amount of information already accumulated we are only just beginning to understand some of the evolutionary processes involved in the speciation of mosses (Szweykoski, 1984). It is very likely that in many groups vigorous evolution has taken place during the last 20 million years (van Zanten & Pócs, 1981) and isozyme studies provide evidence that it is still occurring (Wyatt *et al.*, 1989b, 1993).

Molecular studies have supported a monophyletic lineage for the haplolepidous peristome (Newton *et al.*, 2000 and others), have revised the interpretation of genera in the Orthotrichaceae (Goffinet *et al.*, 1998), led to the transfer of *Amphidium* to the diplolepidous mosses and excluded *Bryobartramia* from the Dicranales. It has resolved three major clades

within the haplolepidous mosses, and has highlighted the polyphyly of families such as the Bryaceae, Sematophyllaceae and Orthotrichaceae. The circumscription of some families has been reassessed and some genera have been moved elsewhere, e.g. *Pohlia* and *Schizymenium* to the Mniaceae and *Orthodontium* to the Orthodontiaceae, while *Campylopus* has been incorporated into the Leucobryaceae. The contribution of molecular data to the systematics of the Bryineae (*sensu* Vitt, 1984) has demonstrated that the acrocarpous and diplolepidous-alternate peristomate mosses gave rise to the pleurocarpous mosses (Goffinet & Buck, 2004).

"As bryologists move into the twenty-first century, all sources of data that allow for better resolution of phylogenetic relationships are needed, and molecular sequences offer the best hope for understanding not only familial circumscriptions and phylogeny, but ultimately also the evolution of morphological characters. It is, indeed, the history of morphological transformations that define taxa or of the distribution ranges of the species that justify the investment into phylogenetic approaches. A revival of critical morphological and anatomical studies is, however, imperative if major clades of mosses are to be diagnosed by characters other than genomes" (Goffinet & Buck, 2004).

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FOSSIL RECORD OF BRYOPHYTES

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The fossil record of bryophytes is poor compared to that of vascular plants, and the Australian record is particularly sparse. Bryophytes are probably rarely fossilised because they lack the resistant structures typically found in vascular plants, e.g. thick cuticles and lignified vascular tissues. Fossil bryophytes may also have been ignored because of their small size, or they may have been destroyed by many of the commonly used methods of extracting vascular plant fossils from sediments.

There are certain clear biases in the fossil record of bryophytes. Some higher order taxa are undoubtedly preserved more readily than others (e.g. more robust mosses rather than hepatics; see Schuster, 1981). Other taxa (e.g. certain thallose hepatics) might have been overlooked due of their non-descript gross morphology. Moreover, fossil spores of some hepatics, anthocerotes and *Sphagnum* are more readily recognised because these taxa have large, distinctive and resistant propagules. Preserved spores of other bryophytes may well occur in sediment, but they are often overlooked, either through loss in processing or due to an absence of distinctive features.

Records of fossil bryophytes are more common from higher latitudes (Ovenden, 1993) than from the subtropics and tropics (Frahm, 1993). This is due in part to the greater relative abundance of mosses in cool-climate floras, and probably also because of more rapid weathering of sediments at low latitudes. Similarly, records from glacial periods are more informative than those from interglacials during the Pleistocene (Miller, 1984). Records are also more numerous in younger than in older sediments, presumably because of the comparative paucity of resistant structures, and perhaps also because global cooling during the Cainozoic favoured bryophytes.

Nevertheless, there is a long and rich fossil record of bryophytes. Figure 1 provides a time scale annotated with some of the major events in the bryophyte fossil record. Beautifully preserved macrofossils are sometimes isolated from various types of rock, including fine-grained permineralised sediments, unsubstituted fine-grained sediments with organic preserved fossils, from Quaternary peats and in amber.

The types of structures preserved and the state of systematics influence our understanding of the fossil record of bryophytes. The record is dominated by spores and the leafy or thallose parts of gametophytes. The gametophytes of most bryophytes tend to be larger and longer-lived than the sporophytes, and the spores are highly resistant, widely dispersed and produced in great numbers. Gross morphology and the anatomy of bryophyte leaves and thalli are often highly distinctive, and some species can be readily distinguished using these features. These attributes can also be preserved in the fossil record, and they are well documented in the taxonomic literature (including keys and floras descriptions). Unfortunately, identification can be complicated by convergence among families and genera. Consequently, there is a high probability of readily and reliably identifying well-preserved fossils of species closely related to extant taxa; when the relationship is more remote any inferred affinity to living taxa rapidly becomes less reliable. Thus, extant species and, often, extinct species of extant genera can be accurately identified, and well-preserved Cenozoic fossil bryophytes can often be named. On the other hand, the affinities of older fossils are often very obscure, even to the point of being uncertain whether they represent mosses, liverworts, hornworts or, indeed, bryophytes. Apart from the exceptions noted above,

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spores are rarely identified more precisely than to family level, presumably due to the absence of taxonomically meaningful characters and a general lack of knowledge of bryophyte spore morphology, particularly among palaeo-palynologists.

Recent reviews of aspects of the fossil record of the bryophytes include those of Lacey (1969), Dickson (1973), Krassilov & Schuster (1984), Miller (1984), Taylor & Taylor (1993), Balme (1995) and Kenrick & Crane (1997).

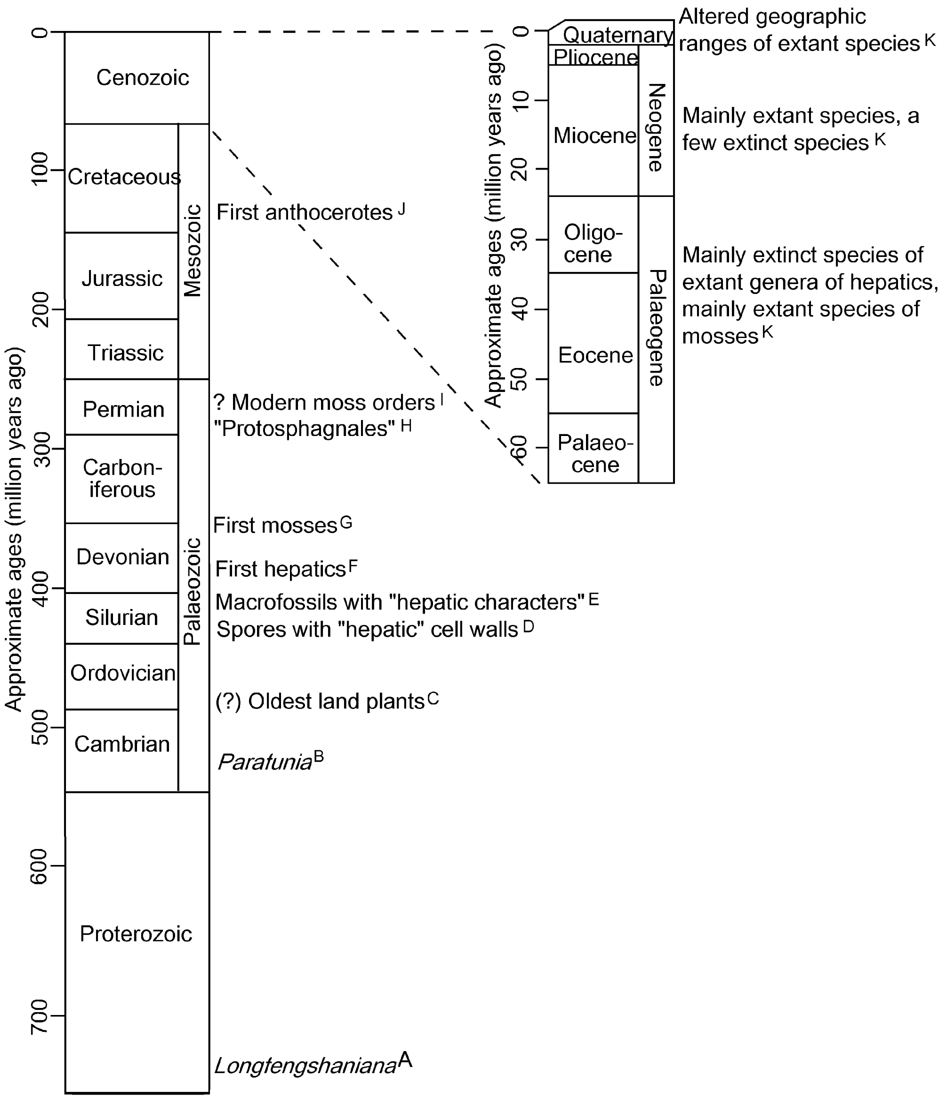


Figure 1. The geological time scale with some of the major events in the fossil record of bryophytes (ages are approximate). Sources of information: A, Zhang (1988); B, Yang *at al.* (2004); C, Gray (1985); D, Taylor (1995); E, Edwards *et al.* (1995); F, Thomas (1972); G, Schuster (1981); H, Neuburg (1960); I, Ignatov (1990) and Smoot & Taylor (1986); J, Dettman (1963), Jarzen (1979) and Drinnan & Chambers (1986); K, Krassilov & Schuster (1984) and Miller (1984).

Origin of the Bryophytes

A combination of the fossil record and phylogenetic analysis of modern taxa indicates that the major groups of bryophytes are very ancient and arose near the time of the earliest land plants (Shaw & Renzaglia, 2004). The land plants, including bryophytes, are probably monophyletic and, within this larger group, the tracheophytes are also very likely to be monophyletic. However, the relationships among the tracheophytes and the three major lineages of bryophytes (mosses, hepatics and anthocerotes) remain unclear, with different phylogenetic analyses showing almost all possible arrangements of these groups. While it is often very difficult to recognise features of modern plants in many early land plants, the fossil record does provide some hints about the origin of the bryophytes.

Some of the oldest of all terrestrial plant fossils resemble hepatics. An extreme example is the claim that the Precambrian *Longfengshania* is probably a liverwort (Zhang, 1988; Fig. 1), although it could also be interpreted as an alga. Moreover, Yang *et al.* (2004) described a bryophyte-like fossil, *Parafunia sinensis*, from Early-Middle Cambrian sediments, with structures they interpreted as whorled leaves, a capsule, seta and complex rhizoidal structures. This fossil occurred in the same sediments as cryptospores (spores having some of the features of terrestrial plant propagules), and the sediments also contained a diverse fossil assemblage of shallow marine organisms.

The earliest convincing evidence of terrestrial plants is found in Ordovician spores with resistant walls suggesting a terrestrial existence (Gray, 1985). Silurian spores, similar to one type of the Ordovician 'land plant' spores, have a wall ultrastructure similar to that seen in extant hepatics especially the Sphaerocarpales (Taylor, 1995). Earliest Devonian macro-fossils with anatomical similarities to hepatics contained spores similar to another type of Ordovician 'land plant' spore (Edwards *et al.*, 1995). However, as discussed by Edwards (2000), differences between the morphology of ancient fossils and that of any living plant, the relatively poor preservation of some fossils and the primitive character of many of the structures (and hence similarity to only distantly related primitive taxa) together mean that the earliest fossil land plants are open to various interpretations. Consequently, such fossils are often described as evidence of terrestrial plants of a bryophyte grade, representing either ancient bryophytes, or land plants with primitive features that make them resemble bryophytes.

Fossil Record of Hepatics

Apart from the possible records listed above, hepatics were clearly present by the Devonian (*Pallavicinites devonicus* (Hueb.) R.M.Schust.; Heuber, 1961; Schuster, 1981). *Pallavicinites* has attributes of the comparatively advanced "simple thalloid I" group of hepatics (Schuster, 1981; Shaw & Renzaglia, 2004). It is, therefore, likely that hepatics were well differentiated by this time. Furthermore, most of the Mesozoic fossils are of the Metzgeriales (Krassilov & Schuster, 1984; Miller, 1984) which is an advanced group. Schuster (1981) argued that the early occurrence of apparently advanced forms is due to biases against fossilisation of primitive hepatic forms. Fossil evidence regarding the Sphaerocarpales may help to resolve this dilemma. The Triassic fossil *Naiadita lanceolata* Brodie has sporophyte characters and spore wall ultrastructure indicating a position in the Sphaerocarpales but, like Calobryales, the gametophytes are erect and radially symmetrical (Hemsley, 1989), i.e. key attributes of Schuster's (1981) putative ancestral hepatic. Together with the evidence from Taylor (1995) and Edwards *et al.* (1995) that very early land plants had sphaerocarpalean characters (see discussion above), this leaves open the possibility that the earliest hepatics were proto-sphaerocarpaleans with radially symmetrical gametophytes.

A number of Mesozoic fossil taxa can be assigned with some confidence to major groups of modern hepatics. Thus, the Cretaceous *Diettertia* is clearly a member of the order Jungermanniales and, apparently, a highly derived form within that order; this suggests an early origin for the order (Schuster & Janssens, 1989). Convincing fossils of the Marchantiales are known from the Jurassic including ones associated with spores consistent with the extant genus *Riccia* and other taxa (Lundblad, 1954; Balme, 1995). Few Mesozoic

hepatics can be assigned to extant families, and although occasional fossils have been assigned to extant genera, there is considerable uncertainty about their identity. An Australian example, *Riccardia koonwarriensis*, was described from the Aptian Koonwarra Fish Beds in Victoria (Drinnan & Chambers, 1986).

In marked contrast to Mesozoic fossils, almost all well-preserved Cenozoic hepatic fossils are clearly attributable to modern genera, which suggests that many, including highly advanced taxa, were extant by the end of the Cretaceous (Schuster & Krassilov, 1984). The extant leafy liverwort genera *Porella* and *Frullania* are represented by beautifully preserved specimens in the Eocene Baltic amber (Grolle & So, 2004). Schuster (1981) argued that the high specific and generic diversity of hepatics in the Cenozoic reflects an sudden, dramatic increase in the diversity of epiphytic taxa, particularly of five families of the Marchantiales (Lejeuneaceae, Jubulaceae, Radulaceae, Porellaceae and Plagiochilaceae), in response to the Late Cretaceous and Paleogene expansion of angiosperm abundance and diversity. Palaeogene hepatics tend to be of extinct species, although a few are virtually identical to extant taxa (Miller, 1984). For example, of the 20 species of hepatic found in the Middle Eocene-Early Miocene Dominican amber, 12 represent extinct species, three are of extant species, and there is insufficient information to determine whether the remaining five are extinct or not (Gradstein, 1993). By contrast, most Neogene fossils are morphologically consistent with extant species (Miller, 1984). There is an implication that the typical turnover time of hepatic species is probably 10–30 million years, which is long, especially when compared with angiosperms. If hepatic diversity was greater in the past, these figures may be incorrect, either because there were many extinct species with similar gametophyte morphology (and hence the turnover time could be shorter), or because there were so many Palaeogene species that the extant species were masked in the fossil record by extinct species (and hence the turnover time could be longer).

Fossil Record of Anthocerotes

The only unambiguous, macrofossil anthocerote is a member of the Dendrocerotaceae found in the Eocene-Early Oligocene Dominican amber (Frahm, 2005). Drinnan & Chambers (1986) described *Dendroceros victoriensis* from the Aptian (Early Cretaceous) Koonwarra Fish Beds in Victoria, Australia. Provided the detached structures considered by the authors to be sporophytes were actually part of the living plant, these fossils are undoubtedly anthocerotes, and they probably represent *Dendroceros*. If not, it is plausible that they were hepatics. Anthocerote spores certainly occur in nearby correlatives of these sediments (Dettmann, 1986). There are Cretaceous spores in North America (Jarzen, 1979) and in Australia (Dettman, 1994) that are almost certainly anthocerotes and resemble propagules of the extant genus *Phaeoceros*. Dettmann (1994) also recorded spores that probably represent other anthocerote genera, and many anthocerote spores are known from the Cenozoic (Jarzen, 1979).

Fossil Record of Mosses

Fossil mosses are less common than hepatics during the Mesozoic and especially the Palaeozoic, even though Cenozoic fossils of mosses are much more common than hepatics from that period. The oldest known fossil moss is the Early Carboniferous *Muscites plumatus* from Gloucestershire, England (Thomas, 1972). Neuberg (1960) observed a rich moss flora from the Early Permian which Krassilov & Schuster (1984) suggested were from a single group of mosses (Protosphagnales) of unknown modern affinities. A Late Permian flora from the Russian Platform is of particular interest since it contains beautifully preserved leaves and leafy gametophytes which appear to represent five extant orders, *viz.* Dicranales, Pottiales, Funariales, Leucodontales and Hypnales (Ignatov, 1990). The oldest Southern Hemisphere moss, and the oldest bryophyte with anatomical preservation of the gametophyte, is the permineralised *Merceria augustica* from the Transantarctic Mountains, which appears to confirm the differentiation of the Bryales, probably the Bryidae (Smoot & Taylor, 1986).

The Mesozoic record of mosses is similar to that of the hepatics in that a number of extant major groups became known, but extant genera have rarely been identified (Krassilov & Schuster, 1984). Late Cretaceous (Campanian) sporophytes and gametophytes of an extinct member of the Polytrichaceae, *Eopolytrichum antiquum*, are known from North America (Konopka *et al.*, 1997). The presence of both sporophytes and gametophytes means that this is a highly reliable identification.

The Cenozoic fossil record of mosses is comparatively rich, with many more mosses than hepatics known from this time. The overwhelming feature of this record is the similarity to modern floras, and almost all of the fossils are indistinguishable from modern species, even in the Paleogene (Miller, 1984). For example, among 55 very well-preserved moss specimens from the Eocene Baltic amber, most have been identified as belonging to 11 extant species, the remainder are assigned to living genera, but without preservation of the organs necessary to identify them to species level (Frahm, 2004).

Occasionally, Cainozoic fossils clearly represent extinct species. For example, in the Neogene Ellesmere Island flora from the high Arctic, two of 57 moss taxa were different to all known extant species (Ovenden, 1993). A possible explanation is that the turnover time of moss species is very long, often tens of millions of years, and even slower than for hepatics among which Palaeogene fossils tend to be of extinct species. However, it is also possible that his difference might be partly due to a lesser amount of differentiation between species within moss genera in comparison with hepatics, and perhaps different attitudes to identification on the part of the palaeobotanists involved, i.e. whether they tended to assign fossils to living species, as opposed to describing new species on limited information, or to leave specimens without formal description.

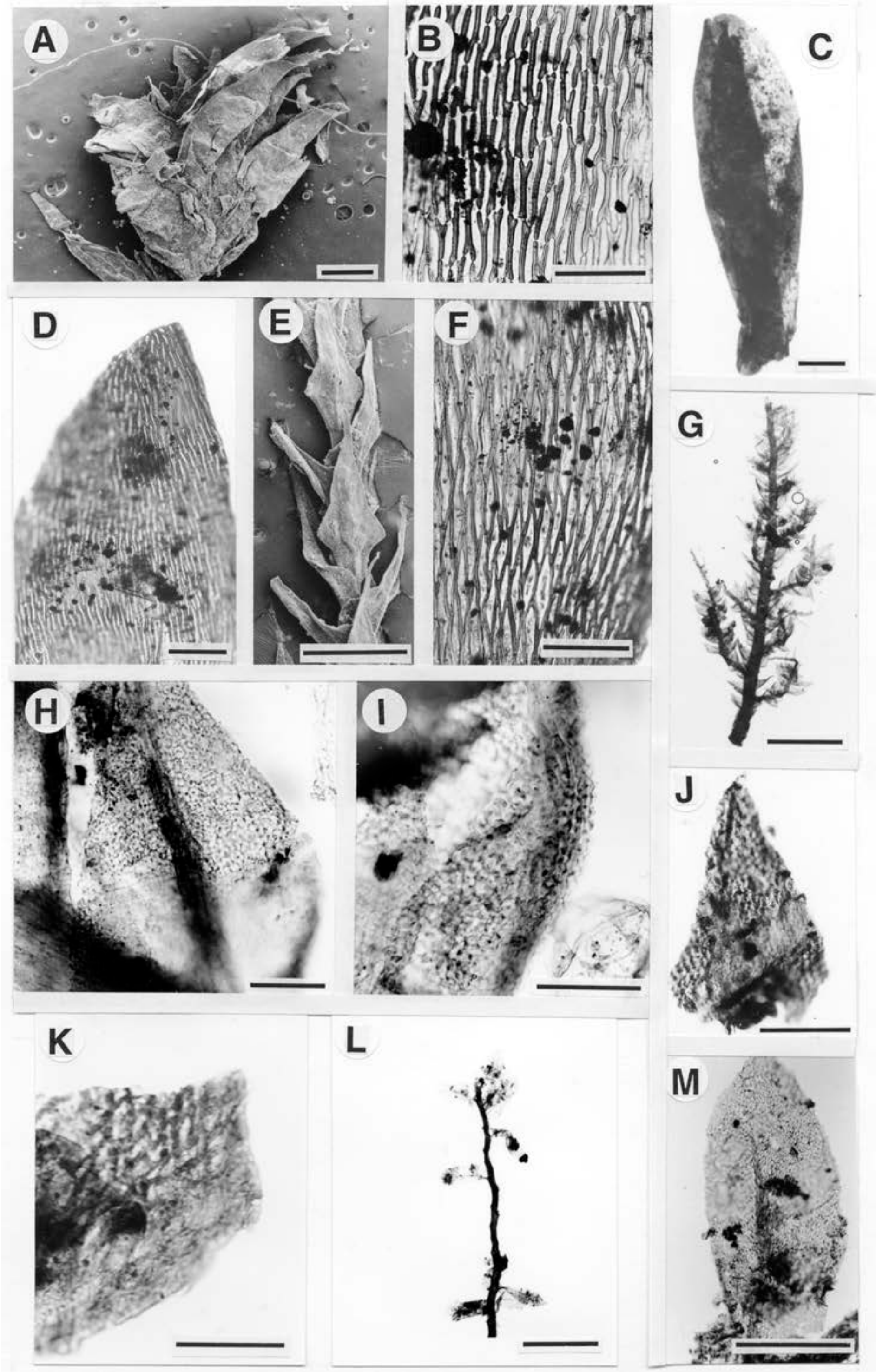
The long species turnover time in mosses and hepatics may be due to a combination of factors, including rarity of sexual reproduction and resilience to macroclimatic change. This resilience may also be related to very high dispersal ability and a tendency for distributions to be determined by microclimate rather than macroclimate.

There have been marked changes in the distribution of taxa even in comparatively recent times. Some are of taxa tracking well-defined macroclimatic changes (e.g. bryophytes having more poleward distributions during warm interglacial periods than during glacials), but a few taxa appear to contradict the trends (Miller, 1984). These trends are consistent with the commonly held view, based on the ranges of modern taxa, that the distribution of most bryophytes is determined primarily by suitable microclimatic conditions rather than by macroclimate.

The Australian Fossil Record

Apart from spores, there are few fossil bryophytes of any age in Australia, and these show similar trends to the global fossil record. The Aptian (Early Cretaceous) Koonwarra Fish Beds contain the richest Mesozoic fossil bryophyte flora in Australia (Drinnan & Chambers, 1986). The preservation of these fossils is moderate at best, and all the identifications are

Figure 2 (opposite). Some fossil mosses from south-eastern Australia. **A–F**, Fossils from Early Pleistocene Regatta Point sediments in western Tasmania. **A**, Leafy stem fragment of *Ptychomnion aciculare* (Ptychomniaceae); **B**, Cells from mid-leaf of *Ptychomnion aciculare*; **C**, Leaf of *Weymouthia mollis* (Lembophyllaceae); **D**, Cells from apex and mid-leaf of *Weymouthia mollis*; **E**, Leafy stem fragment of *Papillaria* sp. (Meteoriaceae); **F**, Cells from mid-leaf of *Papillaria* sp. **G–M**, Fossil mosses from Mid-Miocene sediments at Elands, central-eastern New South Wales. **G**, Leafy stem fragment of unidentified Species A; **H**, Leaf of Species A; **I**, Folded portion of a leaf of Species A; note the papillae; **J**, Leaf of unidentified Species B; **K**, Mid-leaf cells of Species B; note the thick-walled, smooth, rhomboidal cells; **L**, Leafy stem fragment of unidentified Species C; note the sparse, possibly flattened phyllotaxy; **M**, Leaf of Species C; note the thin-walled, smooth, rhomboidal cells. Scale bars: A and E, 0.5 mm; B, D, F, H, I and K, 50 µm; C and M, 0.2 mm; J, 100 µm; G and L, 1 mm.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open to alternative interpretations. The fossils included gametophytes of leafy hepatics (?*Jungermannia*, ?*Plagiochila* and Jungermanniales indet.), one probable thallose hepatic (*Riccardia koonwarriensis*), several possible thallose hepatics (*Hepaticites* spp. and *Thallites* sp.), and probable moss gametophytes (two types) and sporophytes (two types). The fossils described as the anthocerote *Dendroceros victoriensis* are discussed above.

Douglas (1973) described a Cretaceous thallose hepatic (*Hepaticites discoides*), but the state of preservation precludes recognition of its relationship to extant taxa. Selkirk (1974) identified persistent protonemata and haptera resembling the extant epiphyllous moss *Ephemeropsis* on Early Miocene cuticle from Kiandra. Clifford & Cookson (1953) described a moss capsule of unknown affinity from the Oligo-Miocene sediments at Yallourn, although re-examination of this specimen has led to some doubt about its identification (P.J.Dalton, pers. comm.). Although hepatic spores are common, particularly those similar to Ricciaceae, the only Cenozoic macro-fossil record is a member of Jungermanniales in the Early-Middle Miocene Yallourn Formation in the Latrobe Valley coal. Spores of *Phaeoceros* and Sphagnaceae occur in Australia from the earliest Cretaceous (Dettmann, 1994). Several types of hepatic spore (*Riella* or *Riccia* and others) also occur in the Early Cretaceous (Dettmann, 1994). Spores of most of these types and some other likely bryophytes occur in the Cenozoic (Macphail *et al*., 1993, 1994). A fossil flora from Early Pleistocene at Regatta Point sediments in western Tasmania contains a suite of fossil mosses (Jordan & Dalton, 1995). Two of these, *Ptychomnion aciculare* and *Weymouthia mollis*, can be confidently assigned to extant wet-forest species and another, *Papillaria* sp., appears to be of a species which is at least regionally extinct (Fig. 2A–F). Several as yet unidentified moss taxa (Fig. 2G–M) occur in an Early-Middle Miocene fossil flora from Elands in eastern New South Wales (Barnes & Hill, 1999).

Conclusions

The fossil record shows that at least two of the major bryophyte lineages are very ancient. The hepatics were already differentiated into subgroups at least back to the Devonian, and the mosses to the Early Carboniferous. By inference, the anthocerotes are also likely to be Palaeozoic in age. Prior to this there are spores and traces of conducting tissue which have certain hepatic characteristics, and it is plausible that these fossils represent early hepatics or extinct lineages close to the common ancestors of bryophytes and vascular plants. Several of the major modern orders within the mosses first appear in the Late Permian, as well as at least one group (Protosphagnales) which is difficult to convincingly link with any modern taxon. The modern orders of hepatics mostly appear later, in the Cretaceous or Cenozoic, possible exceptions being the Metzgeriales and the Sphaerocarpales. Most Palaeozoic hepatics are assigned to the Metzgeriales, and many of the most ancient land plants share characters with the Sphaerocarpales. In both cases, it is possible that the fossils are identified on the basis of shared primitive characters, although this still suggests that the lineages leading to these orders are very ancient. Anthocerotes do not appear until the Cretaceous. Mesozoic and Palaeozoic mosses and hepatics are usually of extinct genera and probably families, but Cenozoic fossils are usually referable to modern genera. All first appearances based on fossil evidence are minimum ages for these taxa, and actual first occurrences may be much older, especially considering the sparseness of the bryophytes record. There are many moss fossils and some hepatics from Cenozoic sediments, indicating that moss species often exist for a very long time, perhaps tens of millions of years, i.e. much longer than angiosperm species. Hepatic species also appear to exist for millions of years, but perhaps not as long as mosses.

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KEY TO THE GENERA OF AUSTRALIAN MOSSES

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This key is based on the diagnostic characters of *Key to the Genera of Australian Mosses* (W.R.Buck, D.H.Vitt & W.M.Malcolm, Flora of Australia Supplementary Series No. 14, Australian Biological Resources Study, Canberra, 2002). Genera documented in this volume of the *Flora of Australia* are in capital letters.

1 Gametophytes seemingly absent; plants consisting only of protonemata and 1 or a few perichaetial leaves 2

1: Gametophytes present, with obvious leaves 8

2 Plants epiphytic *(1)* .... **Ephemeropsis**

2: Plants terrestrial 3

3 Capsules symmetrical, cleistocarpous *(2:)* 4

3: Capsules asymmetrical, stegocarpous and peristomate 6

4 Capsules with a distinct seta; seta translucent, very short (to 0.6 mm), erect *(3)* .... **Viridivellus**

4: Capsules lacking a distinct seta 5

5 Gametophores completely hidden by the dense glossy protonemata; capsules ovoid, with a small apiculus; calyptra campanulate *(4:)* .... **EPHEMERUM** (p. 163)

5: Gametophores exposed above the protonemata; capsules rounded, not apiculate; calyptra vestigial .... **ARCHIDIUM** (p. 147)

6 Vestigial leaves radially arranged, almost colourless, ecostate; peristome double *(3:)* .... **Buxbaumia**

6: Vestigial leaves distichous, chlorophyllose, costate; peristome single 7

7 Sheathing part of leaves with a dorsal lamina, Y-shaped in transverse section; costa well defined throughout *(6:)* .... **Fissidens**

7: Sheathing part of leaves lacking a dorsal lamina, broadly U-shaped in transverse section; costa weak, ±filling the subula, absent below .... **Nanobryum**

8 Laminal cells a network of narrow green cells alternating with large hyaline cells; branches usually in fascicles *(1:)* 9

8: Laminal cells uniformly green or, if dimorphic, branches never in fascicles 10

9 Stems with a differentiated cortex; branches in fascicles; leaves bordered by few thick-walled cells; hyaline laminal cells always unistratose *(8)* .... **SPHAGNUM** (p. 90)

9: Stems lacking a differentiated cortex; branches mostly not in fascicles (but sometimes paired); leaves bordered by numerous thin-walled cells; hyaline laminal cells sometimes bistratose .... **AMBUCHANANIA** (p. 105)

10 Leaves attached in 2 rows on opposite sides of the stem (distichous) *(8:)* 11

10: Leaves attached all around the stem [foliate stems sometimes flattened, or plants essentially stemless] 15

11 Leaves appearing split at the base, comprising 2 vaginant laminae that clasp the stem and base of the leaf above, at least at the stem apex *(10)* 12

11: Leaves lacking vaginant laminae, clasping the leaf above or not 13

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12 Vaginant laminae composed mostly of thin-walled hyaline cells; pseudoparaphyllia foliose; capsule immersed *(11)* .... **Sorapilla**

12: Vaginant laminae composed mostly of chlorophyllose cells (except sometimes with a narrow limbidium); pseudoparaphyllia absent; capsule exserted .... **Fissidens**

13 Plants minute, to 1.5 mm tall *(11:)* .... **Nanobryum**

13: Plants larger, more than 5 mm tall 14

14 Leaves subulate *(13:)* .... **Distichium**

14: Leaves lanceolate to ovate .... **RHIZOGONIUM** (p. 364)

15 Leaves with lamellae or filaments on the adaxial (upper) surface (excluding propagula) *(10:)* 16

15: Leaves without lamellae or filaments on the adaxial surface (propagula sometimes present) 26

16 Leaves with filaments on the adaxial surface of the costa *(15)* 17

16: Leaves with lamellae on the adaxial surface of the costa 18

17 Leaf margin broadly inrolled and almost obscuring the filaments; filaments covering most of the costa and the lamina *(16)* .... **Aloina**

17: Leaf margin reflexed to revolute; filaments only on the costa .... **Crossidium**

18 Leaves with elongate marginal cells *(16:)* .... **ATRICHUM** (p. 126)

18: Leaves without elongate marginal cells 19

19 Lamellae 2–4; plants small, less than 5 mm tall *(18:)* 20

19: Lamellae more than 20; plants more than 20 mm tall 21

20 Capsule cleistocarpous, immersed *(19)* .... **Acaulon**

20: Capsule dehiscent, exserted .... **Pterygoneurum**

21 Peristome bristle-like, projecting from the capsule mouth *(19:)* .... **DAWSONIA** (p. 128)

21: Peristome of short blunt rigid teeth, ±level with the capsule mouth 22

22 Capsule angular in cross-section *(21:)* 23

22: Capsule rounded in cross-section 24

23 Capsule 2-angled, convex on one surface; hypophysis absent; calyptra naked except for an apical tuft of hairs *(22)* .... **POLYTRICHADELPHUS** (p. 136)

23: Capsule 4–6-angled; hypophysis present; calyptra densely hairy .... **POLYTRICHUM** (p. 140)

24 Calyptra naked; peristome of 16 or 32 teeth *(22:)* .... **NOTOLIGOTRICHUM** (p. 132)

24: Calyptra hairy; peristome of 64 teeth 25

25 Exothecial cells mammillose; stomata absent *(24:)* .... **POGONATUM** (p. 133)

25: Exothecial cells flat; stomata present .... **POLYTRICHASTRUM** (p. 137)

26 Leaves without a costa, or costa apparently lacking or double (short or long) *(15:)* 27

26: Leaves with a single costa to at least mid-leaf 124

27 Although apparently lacking, costa single and occupying almost the entire lamina; leaves thus appearing multistratose, composed of a central layer of green cells and 1–4 layers of hyaline cells above and below *(26)* 28

27: Costa truly lacking or double; lamina always unistratose 31

28 Chlorophyllose cells 3-sided in section *(27)* .... **Octoblepharum**

28: Chlorophyllose cells 4- or 5-sided in section 29

29 Chlorophyllose cells restricted to a single central row; hyaline cells of the upper leaves in 1 or 2 rows on both sides of the chlorophyllose cells *(28:)* .... **Leucobryum**

29: Chlorophyllose cells in 3 rows separated by 3–6 rows of hyaline cells 30

30 Leaves fragile; upper surface smooth *(29:)* .... **Arthrocormus**

30: Leaves not fragile; upper surface rough .... **Exostratum**

31 Plants small, less than 2 mm tall, ephemeral, on soil *(27:)* 32

31: Plants larger, more than 3 mm tall, perennial, on various substrata 33

32 Leaves broadly ovate, entire; capsule operculate *(31)* .... **Goniomitrium**
32: Leaves oblong to lanceolate, entire to serrate; capsule cleistocarpous .... **EPHEMERUM** (p. 163)

33 Upper laminal cells papillose, prorulate or conspicuously ornamented *(31:)* 34
33: Upper laminal cells smooth or somewhat bulging 60

34 Leaf apex hyaline *(33)* 35
34: Leaf apex concolorous 36

35 Leaves less than 1 mm long; plants growing on bark or rock *(34)* .... **ERPODIUM** (p. 168)
35: Leaves more than 1 mm long; plants growing on rock .... **Hedwigia**

36 Leaves appearing lacquered when dry, bordered by smooth elongate cells; laminal cells densely pitted but appearing finely pluripapillose *(34:)* .... **Rhacocarpus**
36: Leaves dull to glossy but not appearing lacquered, not bordered; laminal cells truly papillose 37

37 Laminal cells pluripapillose *(36:)* 38
37: Laminal cells unipapillose or prorulate 44

38 Laminal cells short with scattered papillae *(37)* 39
38: Laminal cells elongate with papillae in rows 41

39 Peristome well developed; calyptra plicate *(38)* .... **ERPODIUM** (p. 168)
39: Peristome absent; calyptra not plicate 40

40 Leaf margin recurved ±throughout *(39:)* .... **Hedwigidium**
40: Leaf margin plane .... **ERPODIUM** (p. 168)

41 Costa strong and double, usually ending at mid-leaf *(38:)* .... **Pseudohypnella**
41: Costa short and double or absent 42

42 Leaves hairpointed *(41:)* .... **Wijkia**
42: Leaves gradually acuminate 43

43 Leaves falcate; alar cells large and inflated *(42:)* .... **Radulina**
43: Leaves straight; alar cells only slightly enlarged and inflated .... **Taxithelium**

44 Plants acrocarpous, small, black or dark red-brown, on rock *(37:)* .... **ANDREAEA** (p. 109)
44: Plants pleurocarpous, larger, not black, on various substrata 45

45 Laminal cells unipapillose *(44:)* 46
45: Laminal cells prorulate 52

46 Costa extending more than half the leaf length *(45)* .... **Callicostella**
46: Costa extending less than 25% of the leaf length 47

47 Leaves strongly ranked on the branches *(46:)* 48
47: Leaves evenly spaced on the branches 49

48 Leaves abruptly constricted above; leaves 5-ranked; alar cells yellowish *(47)* .... **Papillidiopsis**
48: Leaves gradually acute to acuminate; leaves 3-ranked; alar cells dark red .... **Clastobryum**

49 Laminal cells c. 2–4: 1 *(47:)* 50
49: Laminal cells linear, more than 5: 1 51

50 Leaf apex acuminate; peristome double *(49)* .... **Acanthorrhynchium**
50: Leaf apex acute; peristome single .... **Meiotheciella**

51 Stems adhering to the substratum; leaves mostly falcate-secund; alar cells inflated *(49:)*. **Trichosteleum**
51: Stems pendent; leaves straight; alar cells quadrate, not inflated .... **Barbellopsis**

52 Stem and branch leaves different in size and shape *(45:)* .... **Ctenidium**
52: Stem and branch leaves similar 53

53 Leaves falcate-secund *(52:)* 54
53: Leaves ±erect to wide-spreading 57

54 Alar cells enlarged and inflated in a single row *(53)* .... **Warburgiella**
54: Alar cells scarcely differentiated, or with a single enlarged cell 55

55 Leaves obtuse to acute; upper laminal cells c. 2–3: 1 *(54:)*.. **Fallaciella**
55: Leaves acuminate; upper laminal cells more than 5: 1 56

56 Exothecial cells smooth *(55:)* .... **Ectropothecium**
56: Exothecial cells mammillose.. **Trachythecium**

57 Alar cells many and extending up the margin almost to mid-leaf; leaves imbricate when dry *(53:)*.......... .... **Trachyphyllum**
57: Alar cells few and restricted to the extreme leaf base; leaves spreading when dry.............................. 58

58 Leaves obtuse to broadly acute, homomallous to ±secund *(57:)* .... **Fallaciella**
58: Leaves acuminate, spreading 59

59 Plants complanate-foliate *(59:)*.. **Taxiphyllum**
59: Plants not complanate-foliate, loosely and irregularly spreading................................... **Chaetomitrium**

60 Stems and branches ending in a conspicuous globose tuft of propagula *(33:)*............ **Tetraphidopsis**
60: Propagula sometimes in leaf axils, but not terminating stems and branches 61

61 Leaves strongly bordered by elongate cells *(60:)*.. 62
61: Leaves not or scarcely bordered.. 63

62 Leaves with a long double costa *(61)* .... **Cyclodictyon**
62: Leaves with a short double costa.. **Calyptrochaeta**

63 Costa extending more than half of the leaf length *(61:)* .... **Thamniopsis**
63: Costa ending below mid-leaf or absent 64

64 Upper laminal cells 1–3: 1 *(63:)* 65
64: Upper laminal cells 4: 1 or longer (mostly linear)... 68

65 Alar cells distinct and in ±auriculate areas *(64)* .... **Lembophyllum**
65: Alar cells scarcely differentiated 66

66 Leaves more than 2 mm long; capsule exserted, globose, cleistocarpous *(65:)* ....**Pleurophascum**
66: Leaves less than 1.5 mm long; capsule immersed, operculate 67

67 Leaf apex hyaline; plants epiphytic or on rock; stems creeping *(66:)*.................... **ERPODIUM** (p. 168)
67: Leaf apex usually concolorous; plants growing on soil; stems subterranean (rarely seen) ....**GIGASPERMUM** (p. 144)

68 Leaves conduplicate (strongly keeled and cucullate) *(64:)* 69
68: Leaves plane to concave (stems sometimes complanate-foliate) 72

69 Alar cells well developed *(68)* .... **Isocladiella**
69: Alar cells only weakly developed or absent... 70

70 Leaves symmetrically conduplicate; apices obtuse; seta to 3 mm long *(69:)*..........**Orthorrhynchium**
70: Leaves asymmetrically conduplicate; apices acute to mucronate to short-piliferous; seta longer than 15 mm or shorter than 1 mm 71

71 Stems with a hyalodermis; propagula absent; leaf apex mucronate to short-piliferous; capsule long-exserted *(70:)* .... **Catagonium**
71: Stems with thick-walled cortical cells; propagula common; leaf apex usually acute; capsule immersed ... . **Cryptogonium**

72 Leaves conspicuously undulate *(68:)* 73
72: Leaves plane, concave or plicate (and then sometimes rugose), but not undulate........................... 76

73 Leaves distinctly auriculate *(72)*... **Calyptothecium**
73: Leaves not auriculate 74

74 Leaf apex obtuse to rounded *(73:)*... **Neckeropsis**
74: Leaf apex acute to acuminate.. 75

75 Alar cells scarcely differentiated *(74:)*...**Neckera**
75: Alar cells numerous, quadrate, inflated.. **Pulchrinodus**

76 Leaves irregularly squarrose to squarrose-recurved *(72:)* 77
76: Leaves erect to spreading, not squarrose 78

77 Leaves strongly toothed above; laminal cells thick-walled and porose throughout; capsule strongly plicate *(76)* .... **Ptychomnion**
77: Leaves serrulate above; laminal cells ±thin-walled, not porose above; capsule smooth.......... **Rhytidiadelphus**

78 Leaves broadly obtuse to rounded (but sometimes also apiculate) *(76:)* 79
78: Leaves acute to acuminate 83

79 Alar cells inflated and thin-walled *(78)* 80
79: Alar cells not inflated, thick-walled 81

80 Leaves ±orbicular, deeply concave; stems irregularly branched; plants turgid, autoicous *(79)* .... **Acrocladium**
80: Leaves oblong, c. 2: 1, shallowly concave; stems regularly branched; plants not turgid, dioicous .... **Calliergonella**

81 Stems frondose; branch and stem leaves different in size *(79:)* .... **Camptochaete**
81: Stems not frondose; branch and stems leaves similar 82

82 Laminal cells 10–25 µm long; plants usually terrestrial *(81:)* .... **Lembophyllum**
82: Laminal cells 40–80 µm long; plants usually epiphytic and pendent .... **Weymouthia**

83 Plants with abundant paraphyllia *(78:)* .... **Glyphothecium**
83: Plants with few or no paraphyllia 84

84 Leaves plicate, at least at the base *(83:)* 85
84: Leaves plane or rugose 88

85 Alar cells thick-walled and porose, in small discrete areas; upper leaf margin usually strongly toothed *(84)* 86
85: Alar cells firm-walled but not porose, in large areas; upper leaf margin entire to serrulate 87

86 Leaves distinctly decurrent; exostome teeth papillose to smooth; perichaetial leaves acuminate to cuspidate *(85)* .... **Garovaglia**
86: Leaves not or shortly decurrent; exostome teeth striate; perichaetial leaves aristate .... **Euptychium**

87 Alar cells rounded; capsule immersed to emergent *(85:)* .... **Forsstroemia**
87: Alar cells quadrate to oblate; capsule long-exserted .... **Mesonodon**

88 Leaf apex long-piliferous (concolorous or hyaline) *(84:)* 89
88: Leaf apex acute to acuminate 91

89 Leaves rugose; plants matted with tomentum *(88)* .... **Lepyrodon**
89: Leaves smooth; plants lacking tomentum 90

90 Upper laminal cells porose; alar cells quadrate, not inflated *(89:)* .... **Myurium**
90: Upper laminal cells not porose; alar cells oval, inflated .... **Wijkia**

91 Leaves bordered by broad elongate cells in 2 or 3 rows, the outermost forming large marginal teeth *(88:)* .... **Trismegistia**
91: Leaves not bordered; margin variously toothed to entire 92

92 Plants with a creeping primary stem giving rise to erect frondose secondary stems *(91:)* 93
92: Plants without differentiated stems and without erect frondose secondary stems 95

93 Leaves auriculate; capsule immersed *(92)* .... **Calyptothecium**
93: Leaves not auriculate; capsule exserted 94

94 Alar cells differentiated in a small dark area; upper laminal cells shorter than 50 µm; plants olive-green *(93:)* .... **Camptochaete**
94: Alar cells not differentiated; upper laminal cells longer than 60 µm; plants silvery green .... **Trachyloma**

95 Upper leaf axils with flagelliform branches *(92:)* .... **Isocladiella**
95: Upper leaf axils naked or with filamentous propagula 96

96 Upper leaf axils with filamentous propagula *(95:)* 97
96: Upper leaf axils naked 99

97 Branch leaves 3-ranked *(96)* .... **Clastobryum**
97: Branch leaves complanate-foliate or evenly arranged 98

98 Upper laminal cells thin-walled and non-porose; alar cells absent or few, quadrate and evenly firm-walled *(97:)* .... **Hampeella**
98: Upper laminal cells irregularly thick-walled and porose; alar cells numerous, irregularly thick-walled .... **Eucamptodon**

99 Plants in small tufts on bark and rock; calyptra mitrate *(96:)* .... **Sauloma**
99: Plants forming mats on various substrata; calyptra usually cucullate 100

100 Leaves clearly falcate-secund *(99:)* 101
100: Leaves complanate, homomallous or evenly foliate 108

101 Plants large, turgid, red-brown, in peatlands; leaf apex broadly acute *(100)* .... **Scorpidium**
101: Plants small, not turgid, green, in drier habitats; leaf apex acuminate 102

102 Alar cells inflated, at least in the basal corners *(101:)* 103
102: Alar cells non-differentiated to quadrate, not inflated 105

103 Inflated alar cells solitary in outermost basal corners *(102)* .... **Ectropothecium**
103: Inflated alar cells in 1 or 2 rows 104

104 Leaves circinate with a long serrate apex; alar cells thick-walled; exothecial cells with thick longitudinal walls and thin transverse walls *(103)* .... **Warburgiella**
104: Leaves merely falcate with a serrulate to entire apex; alar cells thin- to firm-walled; exothecial cells collenchymatous .... **Rhaphidorrhynchium**

105 Alar cells numerous and coloured *(102:)* .... **Hypnum**
105: Alar cells undifferentiated or few and hyaline 106

106 Stem homogeneous in cross-section; pseudoparaphyllia absent; leaf margin entire; exostome furrowed *(105:)* .... **Leucomium**
106: Stem with small thick-walled epidermal cells in cross-section; pseudoparaphyllia filamentous; leaf margin serrulate to entire; exostome not furrowed 107

107 Lateral and dorsal leaves different (at least in areolation); laminal cells lax, broad, rhomboidal *(106:)* .... **Vesicularia**
107: Lateral and dorsal leaves similar; laminal cells dense, narrow, linear .... **Isopterygium**

108 Leaves with a long narrow decurrency of 3–5 rows of inflated cells *(100:)* .... **Plagiothecium**
108: Leaves not or scarcely decurrent 109

109 Plants complanate-foliate *(108:)* 110
109: Plants evenly foliate, often julaceous 117

110 Alar cells quadrate and numerous, extending up the margin by more than 5 cells *(109)* .... **Entodon**
110: Alar cells undifferentiated or few, extending up the margin by fewer than 5 cells 111

111 Median laminal cells rhomboidal to oval, less than 8: 1 *(110:)* 112
111: Median laminal cells ±linear, more than 12: 1 113

112 Lateral and dorsal leaves different, straight to somewhat falcate; laminal cells lax and thin-walled *(111)* .... **Vesicularia**
112: Lateral and dorsal leaves similar, homomallous; laminal cells dense and thick-walled .... **Fallaciella**

113 Stem with a hyalodermis *(111:)* .... **Isopterygiopsis**
113: Stem lacking a hyalodermis 114

114 Stem homogeneous in cross-section; pseudoparaphyllia absent *(113:)* .... **Leucomium**
114: Stem heterogeneous in cross-section; pseudoparaphyllia present 115

115 Lateral and dorsal leaves different; laminal cells lax *(114:)* .... **Vesicularia**
115: Lateral and dorsal leaves similar; laminal cells dense 116

116 Upper laminal cells shorter than those at mid-leaf; pseudoparaphyllia foliose *(115:)*..... **Taxiphyllum**
116: Upper laminal cells similar to those at mid-leaf; pseudoparaphyllia filamentous .... **Isopterygium**

117 Alar cells very few and poorly differentiated *(109:)* .... **Rhabdodontium**
117: Alar cells well developed 118

118 Alar cells strongly coloured, very thick-walled *(117:)* .... **Eucamptodon**
118: Alar cells concolorous to hyaline, thin- to firm-walled 119

119 Alar cells quadrate, not inflated, extending up the margin by 15–25 cells *(118:)* .... **Entodon**
119: Alar cells oval to rectangular, ±inflated, extending up the margin by fewer than 6 cells.................... 120

120 Alar cells thin-walled, hyaline, in excavate groups of more than 10 *(119:)* ....**Bryostreimannia**
120: Alar cells mostly firm-walled, yellow, not excavate, in 1 or 2 rows with fewer than 6 cells, often with quadrate supra-alar cells 121

121 Alar cells curved towards the insertion; branch apex cuspidate; exostome teeth furrowed *(120:)* .... **Acroporium**
121: Alar cells not curved towards the insertion; branch apex obtuse; exostome not furrowed.................. 122

122 Peristome single, an exostome only *(121:)* .... **Meiothecium**
122: Peristome double.. 123

123 Exostome teeth much shorter than the endostome segments *(122:)*............................. **Macrohymenium**
123: Exostome teeth as long as or longer than the endostome segments ....**Sematophyllum**

124 Leaves tri- to multistratose, consisting mostly of non-chlorophyllose cells enclosing smaller chlorophyllose cells *(26:)* 125
124: Leaves uni- to bistratose, rarely tristratose, consisting mostly of chlorophyllose cells 129

125 Costa with stereids *(124)* ....**Leucophanes**
125: Costa lacking stereids 126

126 Chlorophyllose cells 3-sided in cross-section *(125:)*...**Octoblepharum**
126: Chlorophyllose cells 4- or 5-sided in cross-section 127

127 Chlorophyllose cells restricted to a single central row; hyaline cells of the upper leaves in 1 or 2 rows on both sides of the chlorophyllose cells *(126:)* .... **Leucobryum**
127: Chlorophyllose cells in 3 rows separated by 3–6 rows of hyaline cells... 128

128 Leaves fragile; upper surface smooth *(127:)*...**Arthrocormus**
128: Leaves not fragile; upper surface rough...**Exostratum**

129 Leaves at least partly 3-ranked, dimorphic, with the lateral ones larger and the ventral or dorsal ones smaller *(124:)* 130
129: Leaves placed all around the stem, uniform 135

130 Leaves not bordered; dorsal leaves present; ventral leaves absent *(129)*...................................... 131
130: Leaves bordered; dorsal leaves absent; ventral leaves present.. 133

131 Plants epiphytic on tree fern trunks; sporophyte terminal *(130)*......................... **CALOMNION** (p. 367)
131: Plants terrestrial or, if epiphytic, not on tree fern trunks; sporophyte lateral 132

132 Laminal cells bulging; seta shorter than 10 mm; capsule erect and smooth; exostome teeth papillose; endostome with a low membrane and no cilia *(131:)* .... **POWELLIA** (p. 371)
132: Laminal cells smooth or unipapillose; seta longer than 15 mm; capsule arcuate and furrowed; exostome teeth striate; endostome with a high membrane and cilia................**RACOPILUM** (p. 373)

133 Stems angular in cross-section, only rarely branched; seta base broadened *(130:)* .... **CYATHOPHORUM** (p. 378)
133: Stems rounded in cross-section, branched; seta base narrow 134

134 Laminal cells isodiametric, thick-walled; plants pinnately branched; seta rough *(133:)*...................... .... **LOPIDIUM** (p. 385)
134: Laminal cells longer than broad and thin-walled; plants pinnately branched to umbellately dendroid; seta smooth .... **HYPOPTERYGIUM** (p. 381)

135 Stems and branches ending in a conspicuous globose tuft of propagula; plants small, on twigs *(129:)* .... **Tetraphidopsis**

135: Stems and branches lacking terminal propagula; plants variable in size and preferred substratum 136

136 Leaf base usually expanded, filled by abruptly differentiated hyaline cells; plants almost always epiphytic *(135:)* 138

136: Leaf base, if expanded, not filled with abruptly differentiated hyaline cells (but sometimes with gradually differentiated hyaline cells); substrata various, but if hyaline basal cells are present plant almost always terrestrial 140

137 Leaves bordered by elongate cells *(136)* 138

137: Leaves not bordered, but margin sometimes thickened or with elongate intramarginal cells 139

138 Plants erect, without a creeping stem; leaves with a usually bi- to multistratose border of narrow hyaline cells *(137)* .... **Syrrhopodon**

138: Plants with a creeping stem and erect secondary branches; leaves with a unistratose border of usually broad hyaline cells .... **Mitthyridium**

139 Calyptra persistent, twisted around the seta below the capsule and with vertical slits above; peristome absent; leaves often with elongate intramarginal cells (teniolae) *(137:)* .... **Calymperes**

139: Calyptra deciduous, cucullate; peristome present or absent; leaves without elongate intramarginal cells .... **Syrrhopodon**

140 Leaves bordered for at least a quarter of their length by elongate cells (sometimes intramarginal) *(136:)* 141

140: Leaves not bordered, except sometimes with a single row of elongate hyaline cells restricted to the leaf base, or else the margin thickened by undifferentiated cells 173

141 Leaf border extending to the apex or nearly so *(140)* 142

141: Leaf border ending well below the apex 163

142 Upper laminal cells papillose *(141)* 143

142: Upper laminal cells smooth 146

143 Alar cells well developed *(142)* 144

143: Alar cells poorly developed or absent 145

144 Capsule inclined and asymmetrical; leaves with short green laminal cells extending to the alar region; smooth elongate cells restricted to the inner basal region *(143)* .... **Sclerodontium**

144: Capsule erect and symmetrical; leaves with short green laminal cells restricted to the upper part of the leaf; smooth elongate cells extending to mid-leaf .... **Leucoloma**

145 Leaf border intramarginal in the upper part of the leaf; propagula on the upper surface of the costa; upper laminal cells with 1 or 2 papillae *(143:)* .... **Calyptopogon**

145: Leaf border marginal throughout; propagula absent; upper laminal cells with 6–8 papillae . **Hennediella**

146 Leaves strongly undulate *(142:)* .... **MESOCHAETE** (p. 358)

146: Leaves plane 147

147 Leaves narrowly lanceolate from an expanded base; plants longer than 15 cm, epiphytic *(148:)* .... **Spiridens**

147: Leaves lanceolate to ovate; plants shorter than 15 cm, on various substrata 148

148 Plants complanate-foliate *(147:)* 149

148: Plants evenly foliate (but sterile shoots of *Plagiomnium* sometimes ±complanate) 153

149 Costa excurrent *(148)* 150

149: Costa ending at mid-leaf to subpercurrent 151

150 Laminal cells thick-walled, porose, longer than 5: 1 *(149)* .... **Dicranoloma**

150: Laminal cells thin- to firm-walled, not porose, shorter than 5: 1 .... **RHIZOGONIUM** (p. 364)

151 Laminal cells thin- to firm-walled and not porose; perichaetial leaves not strongly differentiated in size; alar cells not differentiated *(149:)* .... **Distichophyllum**

151: Laminal cells thick-walled and porose; perichaetial leaves sheathing and tubular; alar cells strongly differentiated 152

152 Leaf margin entire; border narrow *(151:)* .... **Dicnemon**

152: Leaf margin serrulate; border almost half the leaf width .... **Dicranoloma**

153 Sterile and fertile shoots different, the sterile ones arching and the fertile ones erect; laminal cells short-hexagonal *(148)* .... **Plagiomnium**

153: Sterile and fertile shoots similarly erect; laminal cells long-hexagonal to rhomboidal 154

154 Plants forming tufts on trees *(153:)* 155

154: Plants terrestrial 156

155 Leaves less than 2 mm long; calyptra mitrate *(154)* .... **Daltonia**

155: Leaves usually more than 3 mm long; calyptra cucullate .... **BRACHYMENIUM** (p. 277)

156 Plants small; leaves shorter than 3 mm, ±evenly distributed on the stem, usually ovate *(154:)* 157

156: Plants large; leaves longer than 3 mm, often crowded at the stem apex in a comal tuft, usually spathulate 162

157 Leaves obtuse, at least the older ones bright red *(158)* .... **OCHIOBRYUM** (p. 320)

157: Leaves acute to acuminate, mostly green to yellowish green 158

158 Laminal cells usually firm-walled; peristome double; exostome teeth alternating with the endostome segments; perigonial paraphyses with tapering apices *(159:)* 159

158: Laminal cells usually thin-walled; peristome double, single or absent, but, if double, the exostome teeth opposite the endostome segments; perigonial paraphyses with swollen apices 160

159 Stems julaceous; upper and median laminal cells elongate-rhomboidal to vermicular *(158)* .... **BRYUM** (p. 280)

159: Stems never julaceous; upper and median laminal cells rhomboidal .... **PTYCHOSTOMUM** (p. 323)

160 Capsule sulcate when dry; annulus compound and revoluble *(158:)* .... **Funaria**

160: Capsule smooth to wrinkled when dry; annulus simple, sometimes revoluble 161

161 Operculum conical to rostrate; exothecial cells isodiametric; calyptra mitrate *(160:)* ..... **Physcomitrium**

161: Operculum plane to conical; exothecial cells oblong; calyptra cucullate .... **Entosthodon**

162 Erect stems connected by subterranean stolons *(158)* .... **RHODOBRYUM** (p. 328)

162: Erect stems not connected by subterranean stolons .... **ROSULABRYUM** (p. 331)

163 Alar cells well developed *(141:)* 164

163: Alar cells not differentiated 166

164 Leaf margin undulate; laminal cells pluripapillose; capsule immersed *(163)* .... **Mesotus**

164: Leaf margin plane; laminal cells smooth or rarely prorulate; capsule exserted 165

165 Costa filling more than one-third of the leaf base; leaf apex sometimes hyaline *(164:)* .... **Campylopus**

165: Costa filling less than a quarter of the leaf base; leaf apex never hyaline .... **Dicranum**

166 Leaf margin entire *(165:)* 167

166: Leaf margin toothed 170

167 Leaf apex fragile; plants epiphytic *(166)* .... **GROUTIELLA** (p. 189)

167: Leaf apex not fragile; plants on moist soil, tree bases, or rocks in streams 168

168 Costa more than one-third of the width of the leaf base *(167:)* .... **Campylopus**

168: Costa less than a quarter of the width of the leaf base 169

169 Leaves spathulate, obovate or rounded; laminal cells more than 30 µm diam. *(168:)* .... **Orthomnion**

169: Leaves narrowly oblong-lanceolate and narrowly obtuse; laminal cells less than 15 µm diam. .... **Tridontium**

170 Plants complanate-foliate; laminal cells ±isodiametric *(166:)* 171

170: Plants not complanate-foliate; laminal cells long-hexagonal 172

171 Costa ending well below the apex; calyptra mitrate *(170)* .... **Distichophyllum**

171: Costa subpercurrent to excurrent; calyptra cucullate .... **RHIZOGONIUM** (p. 364)

172 Plants usually terrestrial; usually without asexual propagula *(170:)* .... **BRYUM** (p. 280)

172: Plants usually epiphytic; usually with asexual propagula .... **GEMMABRYUM** (p. 287)

173 Stems with abundant paraphyllia *(140:)* 174
173: Stems with very few or no paraphyllia 179

174 Plants stipitate *(173)* 175
174: Plants not stipitate (but the stem and branch sometimes different) 176

175 Plants bipinnately frondose, on trees and rocks; leaf margin subentire; laminal cells short, oval *(174)* .... **Leptodon**
175: Plants dendroid, on soil; leaf margin serrate; laminal cells linear .... **Climacium**

176 Laminal cells and paraphyllia papillose *(174:)* 177
176: Laminal cells and paraphyllia smooth 178

177 Calyptra cucullate *(176)* .... **Thuidium**
177: Calyptra mitrate .... **Pelekium**

178 Stem leaves squarrose-recurved *(177:)* .... **Cratoneuropsis**
178: Stem leaves erect to erect-spreading .... **Cratoneuron**

179 Capsule valvate; plants dark reddish brown to black, usually on montane granitic rock *(174:)* .... **ANDREAEA** (p. 109)
179: Capsule not valvate; plants variously coloured, on various substrata 180

180 Laminal cells papillose, strongly mammillose or prorulate *(179:)* 181
180: Laminal cells smooth or only slightly bulging (but costal cells might be projecting) 268

181 Plants minute, ephemeral, growing on soil *(180)* 182
181: Plants small to large, perennial, growing on various substrata 193

182 Capsule operculate *(181)* 183
182: Capsule cleistocarpous 185

183 Leaf margin plane to recurved; costa with 1 stereid band *(182)* .... **Pottia**
183: Leaf margin incurved to inrolled; costa with 2 stereid bands 184

184 Capsule narrowed towards the mouth, usually with a peristome *(183:)* .... **Weissia**
184: Capsule widest at the mouth, never with a peristome .... **Phasconica**

185 Laminal cells prorulate *(182:)* .... **EPHEMERUM** (p. 163)
185: Laminal cells papillose directly over the lumina 186

186 Capsule exserted *(185:)* 187
186: Capsule immersed 188

187 Capsule angled in cross-section, ridged at the base; costa with 2 stereid bands *(186)* .... **Tetrapterum**
187: Capsule not angled in cross-section, rounded at the base; costa with 1 stereid band .... **Pottia**

188 Vegetative leaves lanceolate; hyaline basal laminal cells extending up the leaf margin as a V; exothecial cells of capsule pustular *(186:)* .... **Trachycarpidium**
188: Vegetative leaves oblong to obovate; hyaline basal cells indistinct or not extending up the margin; exothecial cells flat or mammillose 189

189 Leaves concave with a recurved apex; leaves sheathing the capsule; plants bulbiform *(188:)* .... **Acaulon**
189: Leaves plane with an erect apex; leaves spreading from the capsule; plants not bulbiform 190

190 Costa subpercurrent to percurrent; calyptra inflated and enclosing the entire sporophyte *(189:)* .... **Bryobartramia**
190: Costa excurrent; calyptra not inflated, restricted to the upper half of the capsule 191

191 Costa with 2 stereid bands *(190:)* .... **Uleobryum**
191: Costa with 1 stereid band 192

192 Calyptra large, broadly campanulate-lobed, readily splitting up one side; costa extending below the base of the lamina onto the stem *(191:)* .... **Phascopsis**
192: Calyptra minute to medium-sized, cucullate; costa ending at the leaf base .... **Phascum**

193 Walls of upper laminal cells wavy and irregularly thickened *(181:)* .... **Racomitrium**
193: Walls of upper laminal cells straight and variously thickened 194

194 Laminal cells prorulate *(193:)* ... 195
194: Laminal cells papillose directly over the lumina or rarely over the walls ... 211

195 Leaves plicate, at least at the base *(194)* ... **BREUTELIA** (p. 256)
195: Leaves not plicate ... 196

196 Leaves strongly 5-ranked; plants forming compact mounds on alpine soil *(195:)* ... **CONOSTOMUM** (p. 262)
196: Leaves not conspicuously ranked; habitats and substrata various ... 197

197 Plants erect, scarcely or not at all branched except subflorally *(196:)* ... 198
197: Plants with prostrate stems and spreading to erect branches ... 203

198 Leaf margin entire or obscurely serrulate, not obviously thickened; capsule elliptical to cylindrical; plants small and slender *(197)* ... 199
198: Leaf margin strongly toothed and/or obviously thickened; capsule globose; plants medium-sized ... 201

199 Leaves erect-flexuose from a gradually expanded ovate subsheathing base *(198)* ... **Ditrichum**
199: Leaves twisted from an abruptly expanded obovate sheathing base ... 200

200 Capsule elliptical; peristome teeth vertically pitted *(199)* ... **Dicranella**
200: Capsule cylindrical; peristome teeth papillose ... **Ditrichum**

201 Leaves abruptly narrowed from a sheathing base; plants without subfloral innovations; spores usually only papillose *(198:)* ... **BARTRAMIA** (p. 249)
201: Leaves gradually narrowed from a non-expanded leaf base; plants usually with subfloral innovations; spores usually coarsely ornamented ... 202

202 Leaves erect-appressed when dry; plants usually of mesic habitats *(201)* ... **BARTRAMIA** (p. 249)
202: Leaves loosely erect to spreading; plants of at least seasonally wet habitats .. **PHILONOTIS** (p. 265)

203 Upper laminal cells ±linear, more than 4: 1 *(197:)* ... 204
203: Upper laminal cells ±rounded to short-oval, less than 3: 1 ... 207

204 Plants robust, erect, usually more than 15 mm tall; stipes arising from prostrate primary stem with reduced leaves *(203)* ... 205
204: Plants slender; prostrate, lacking stipes and prostrate primary stem with reduced leaves ... 206

205 Frond elongate, bipinnate; filiform papillose propagula occasionally in upper leaf axils; branch leaves cymbiform with obtuse to truncate or emarginate apices *(204)* ... **Braithwaitea**
205: Frond usually umbellate or palmate; propagula absent; branch leaves flat or weakly concave with acute or acuminate apices ... **Hypnodendron**

206 Leaves ovate-lanceolate; exostome teeth short-truncate, greatly reduced, much shorter than the endostome segments *(204:)* ... **Macgregorella**
206: Leaves lanceolate; exostome teeth lanceolate, not reduced, about the same size as the endostome segments ... **Schwetschkea**

207 Plants distinctly frondose, complanate-foliate; leaves little-altered when dry *(205:)* ... **Pinnatella**
207: Plants only slightly and irregularly branched, ±terete; leaves erect when dry, wide-spreading when moist ... 208

208 Leaf apex gradually long-acuminate *(207:)* ... **Cryphaea**
208: Leaf apex obtuse, acute or abruptly short-acuminate ... 209

209 Leaves short-acuminate; sporophyte terminal on a stem or short branch; peristome single *(208:)* ... **Schoenobryum**
209: Leaves acute to obtuse; sporophyte lateral; peristome double ... 210

210 Plants blackish, robust; leaves longer than 2 mm *(209:)* ... **Dendrocryphaea**
210: Plants greenish, slender; leaves shorter than 1.5 mm ... **Cyptodon**

211 Leaves strongly 3-ranked; upper laminal cells usually with a single deeply forked papilla *(194:)* ... **Triquetrella**
211: Leaves not obviously ranked, or sometimes 5-ranked; upper laminal cells variously uni- to pluripapillose ... 212

212 Upper laminal cells bulging-mammillose to unipapillose; papillae simple *(211:)* 213
212: Upper laminal cells pluripapillose or, if unipapillose, the papillae with multiple branches 228

213 Plants terrestrial, erect to ascending; costa flexuose above; laminal cells stellately thickened; stems with abundant dark brownish red tomentum *(212)* .... **AULACOMNIUM** (p. 245)
213: Plants epiphytic or, if terrestrial, not erect; costa straight; laminal cells not or little thickened in the corners; stems variously tomentose or not 214

214 Upper laminal cells 3: 1 or longer *(213:)* 215
214: Upper laminal cells 2: 1 or shorter 219

215 Upper laminal cells 3–4: 1, rhomboidal to oval; leaf apex acute to rounded-cuspidate *(214)* 216
215: Upper laminal cells more than 6: 1, linear; leaf apex acuminate 217

216 Plants complanate-foliate, terrestrial or on tree bases *(215)* .... **Stereophyllum**
216: Plants terete-foliate, epiphytic and pendent .... **Meteorium**

217 Plants robust; leaves c. 6 mm long and minutely auriculate *(215:)* .... **Pseudospiridentopsis**
217: Plants medium-sized; leaves c. 2–3 mm long and short-decurrent, not auriculate 218

218 Plants complanate-foliate; seta c. 20 mm long *(217:)* .... **Aerobryopsis**
218: Plants terete-foliate; seta c. 2 mm long .... **Meteoriopsis**

219 Leaves obovate *(214:)* 220
219: Leaves lanceolate to ovate 221

220 Plants terete-foliate; propagula on upper surface of costa; costa excurrent in a cusp or hyaline hairpoint *(219)* .... **Tortula**
220: Plants complanate-foliate; upper surface of costa lacking propagula; costa percurrent .. **Bryobrothera**

221 Basal (not juxtacostal) laminal cells short, 2: 1 or less *(219:)* 222
221: Basal laminal cells elongate, 3: 1 or longer 226

222 Stems scarcely or not branched; erect to pendent from tree fern trunks; leaf apex abruptly aristate *(221)* .... **HYMENODON** (p. 256)
222: Stems irregularly to pinnately branched, creeping; leaf apex acute to gradually long-acuminate ... 223

223 Plants glaucous-green *(222:)* .... **PHILONOTIS** (p. 265)
223: Plants bright green to reddish green 224

224 Costa of stem leaves long-excurrent and pellucid; stem leaf apex acuminate; pseudoparaphyllia present *(223:)* .... **Claopodium**
224: Costa of stem leaves percurrent and opaque; stem leaf apex acute; pseudoparaphyllia absent 225

225 Branch leaves erect and imbricate when dry *(224:)* .... **MACROCOMA** (p. 190)
225: Branch leaves variously twisted and contorted when dry .... **MACROMITRIUM** (p. 191)

226 Outer 2 or 3 rows of basal laminal cells markedly different from the innermost ones, with thickened cross-walls *(221:)* .... **ULOTA** (p. 228)
226: Outer basal laminal cells not markedly different from the innermost ones, but sometimes longer and thinner-walled, without thickened cross-walls 227

227 Plants matted, cladocarpous; primary stem creeping but branches erect; capsule usually exserted *(226:)* .... **MACROMITRIUM** (p. 191)
227: Plants tufted, acrocarpous; stems and branches not different; capsule immersed to short-exserted .... **ORTHOTRICHUM** (p. 218)

228 Laminal cells pluripapillose directly over the walls *(212:)* .... **Trachypus**
228: Laminal cells pluripapillose directly over the lumina 229

229 Laminal cells seriately pluripapillose *(228:)* .... **Floribundaria**
229: Laminal cells with papillae scattered over the lumina 230

230 Plants pleurocarpous; stems creeping *(229:)* 231
230: Plants acrocarpous; stems erect 236

231 Branch and stem leaves different; stem leaves narrowly acuminate; branch leaves obtuse to acute *(230)* 232

231: Branch and stem leaves similar 233

232 Calyptra cucullate *(231)* .... **Thuidium**

232: Calyptra mitrate .... **Pelekium**

233 Plants small, slender; branches 2–3 mm long; laminal cells 4–6 µm diam. *(232:)* .... **Haplohymenium**

233: Plants medium-sized, robust; branches longer than 5 mm; laminal cells > 6 µm diam. 234

234 Branches from creeping stems short and erect-ascending *(233:)* .... **MACROMITRIUM** (p. 191)

234: Branches from creeping stems elongate and pendent 235

235 Laminal cells densely papillose; marginal cells smooth or less papillose; plants dark green to blackish *(234:)* .... **Papillaria**

235: Laminal cells sparsely papillose; marginal cells undifferentiated; plants pale green or golden-green .... **Barbella**

236 Laminal cells bistratose to tristratose throughout *(231:)* 237

236: Laminal cells unistratose or bistratose only at the margin 238

237 Leaves ligulate; capsule broad, asymmetrical and sessile *(236)* .... **Diphyscium**

237: Leaves ovate-lanceolate; capsule slender, symmetrical and long-exserted .... **Chrysoblastella**

238 Upper laminal cells with longitudinally striolate papillae over the walls and lumina *(236:)* .... **Amphidium**

238: Upper laminal cells with rounded or C-shaped papillae only over the lumina 239

239 Leaf lamina and margin inrolled to involute *(238:)* 240

239: Leaf lamina and margin plane to recurved 242

240 Leaves oblong-elliptical; laminal cells with a few scattered papillae only on the upper surface *(239)* .... **Hyophila**

240: Leaves lanceolate; laminal cells densely papillose on both surfaces 241

241 Capsule tapering to the mouth; peristome usually present *(240)* .... **Weissia**

241: Capsule widest at the mouth; peristome absent .... **Phasconica**

242 Hyaline basal laminal cells extending up the margin in a V-shape *(239:)* 243

242: Hyaline basal laminal cells undifferentiated or not extending up the margin 244

243 Papillae of laminal cells high and coroniform *(242:)* .... **Tortella**

243: Papillae of laminal cells low and plate-like .... **Pseudosymblepharis**

244 Costa homogeneous in cross-section; stems lacking a central strand; plants usually on trees or rocks *(242:)* 245

244: Costa with stereids and guide cells in cross-section; stems usually with a central strand; plants usually on soil 248

245 Plants small, on calcareous rock; leaves obovate, to 0.5 mm long *(244)* **GYMNOSTOMIELLA** (p. 160)

245: Plants larger, on bark and rock; leaves lanceolate to ligulate, longer than 1 mm 246

246 Laminal cells with 4–7 widely spaced clavate papillae (if papillae fewer, then leaves obtuse); propagula, when present, elliptical and in leaf axils *(245:)* .... **ZYGODON** (p. 237)

246: Laminal cells with fewer than 3 closely spaced conical to irregularly branched papillae; leaves always acute to acuminate; propagula, when present, oblong and on leaf surface 247

247 Leaves usually crispate to contorted when dry; cross-walls of basal marginal cells thickened; capsule short-exserted, with superficial stomata *(246:)* .... **ULOTA** (p. 228)

247: Leaves usually little-altered when dry; cross-walls of basal marginal cells undifferentiated; capsule immersed to short-exserted, with immersed or superficial stomata .... **ORTHOTRICHUM** (p. 218)

248 Costa with 1 stereid band *(244:)* 249

248: Costa with 2 stereid bands 258

249 Leaves constricted below the apex and ending in a deciduous cylindrical sharply apiculate propagulum *(248)* .... **Sarconeurum**

249: Leaves not ending in a cylindrical propagulum 250

250 Leaves ligulate to narrowly lanceolate, never with a hairpoint *(249:)* 251

250: Leaves spathulate, elliptical, oblong or ovate, sometimes with a hairpoint 252

251 Upper leaf margin bistratose; perichaetia terminal *(250)* .... **Trichostomopsis**

251: Upper leaf margin unistratose; perichaetia lateral .... **Anoectangium**

252 Plants minute, scattered on soil or calcareous rock; leaves broadly acute to obtuse, shorter than 0.5 mm *(250:)* 253

252: Plants small to medium-sized, usually tufted on soil or rarely tree trunks; leaves acute to acuminate, longer than c. 1 mm 254

253 Uppermost leaves deciduous, expanded, ventrally bulging and oil-rich, forming propagula; upper leaf margin papillose but otherwise entire *(252)* .... **Stonea**

253: Upper leaves not deciduous; propagula elliptical and in leaf axils; upper leaf margin crenulate with bulging cell walls .... **GYMNOSTOMIELLA** (p. 160)

254 Calyptra large, campanulate, covering the entire capsule *(252:)* .... **Encalypta**

254: Calyptra small, cucullate, covering only the upper part of the capsule 255

255 Leaf apex hairpointed *(254:)* .... **Tortula**

255: Leaf apex acute to acuminate 256

256 Peristome rudimentary or absent *(255:)* .... **Pottia**

256: Peristome of well-developed bifid teeth, with or without a basal membrane 257

257 Peristome teeth free and erect to slightly twisted above; cells of adaxial surface of costa usually larger than or otherwise different from the laminal cells in cross-section *(256:)* .... **Desmatodon**

257: Peristome teeth united in a high or, rarely, low tubular basal membrane and spirally twisted above; cells of adaxial surface of costa smaller than or similar to the laminal cells in cross-section ...... **Tortula**

258 Stem lacking a central strand *(248:)* 259

258: Stem with a distinct central strand 261

259 Leaf margin plane *(258:)* .... **Pseudosymblepharis**

259: Leaf margin recurved to revolute 260

260 Leaf margin strongly toothed *(259)* .... **Leptodontium**

260: Leaf margin entire or only minutely serrulate .... **Hymenostylium**

261 Leaf margin recurved *(258:)* 262

261: Leaf margin erect to plane 264

262 Lower stem and its leaves brick-red *(261)* .... **Bryoerythrophyllum**

262: Lower stem and its leaves green to yellow-brown 263

263 Axillary hairs with a brown basal cell; laminal cells well defined in surface view; leaves usually lanceolate; cells of abaxial surface of costa quadrate to short-oblong, rarely elongate; basal laminal cells usually scarcely differentiated, green and short-rectangular *(262:)* .... **Didymodon**

263: Axillary hairs with all cells hyaline; laminal cells obscure in surface view; leaves usually ovate to oblong; cells of abaxial surface of costa oblong to elongate; basal laminal cells usually strongly differentiated, hyaline and elongate .... **Barbula**

264 Plants epiphytic on cycads; leaves spathulate; leaf margin bistratose; basal laminal cells lax and hyaline *(261:)* .... **Calymperastrum**

264: Plants on soil; leaves oblong; leaf margin usually unistratose; basal laminal cells various 265

265 Stem with a hyalodermis *(264:)* .... **Trichostomum**

265: Stem with thick-walled epidermal cells 266

266 Costa excurrent in a stout mucro; peristome well developed *(265:)* .... **Barbula**

266: Costa subpercurrent to percurrent; peristome poorly developed or absent 267

267 Leaves longer than 1.5 mm; apex a short hyaline apiculus; peristome present *(266:)* .... **Bryoerythrophyllum**

267: Leaves shorter than 1 mm; apex rounded to acute-apiculate; peristome absent .... **Gymnostomum**

268 Walls of upper laminal cells wavy, irregularly thickened *(180:)* .... **Racomitrium**

268: Walls of upper laminal cells straight, variously thickened or porose 269

269 Capsule strongly asymmetrical and emergent *(268:)* .... **Diphyscium**
269: Capsule symmetrical or, if asymmetrical, exserted rather than emergent 270

270 Plants at least partly black, brownish or very dark green; growing on rock *(269:)* 271
270: Plants greenish or whitish; growing on various substrata 272

271 Plants coastal, in the supralittoral zone; capsule operculate *(270)* .... **Muelleriella**
271: Plants not coastal; capsule valvate .... **ANDREAEA** (p. 109)

272 Stems usually creeping or, if erect, well branched; sporophyte usually lateral on stems, or terminating branches *(270:)* 273
272: Stems erect or ascending, scarcely or not branched; sporophyte usually terminal, rarely basal or truly lateral, but sometimes on subfloral innovations and therefore appearing lateral 347

273 Leaves undulate or rugose *(272)* 274
273: Leaves not undulate or rugose, but sometimes concave or plicate 278

274 Costa excurrent *(273)* .... **SCHLOTHEIMIA** (p. 225)
274: Costa ending well below the leaf apex 275

275 Leaf base auriculate *(274:)* .... **Calyptothecium**
275: Leaf base not auriculate 276

276 Plants stipitate-frondose and stiff *(275:)* .... **Pterobryidium**
276: Plants pinnately branched, ±pendent and flaccid 277

277 Leaf apex truncate and blunt; capsule immersed *(276:)* .... **Neckeropsis**
277: Leaf apex broadly acute; capsule short-exserted .... **Himantocladium**

278 Upper laminal cells 2: 1 or shorter and quadrate, rounded, rhomboidal or hexagonal *(273:)* 279
278: Upper laminal cells 4: 1 or longer and usually linear 305

279 Leaves plicate *(278)* 280
279: Leaves not plicate 282

280 Leaf margin bistratose at least above *(279)* .... **Echinodium**
280: Leaf margin unistratose 281

281 Plants terete-foliate; laminal cells thick-walled and strongly porose *(280)* .... **Neolindbergia**
281: Plants complanate-foliate; laminal cells firm-walled, not or only weakly porose .... **Thamnobryum**

282 Costa strongly flexuose in the upper part of the leaf *(279:)* .... **Herpetineuron**
282: Costa straight 283

283 Leaf margin bistratose *(282:)* 284
283: Leaf margin unistratose 288

284 Leaves ovate; apex acute *(283)* .... **RHIZOGONIUM** (p. 364)
284: Leaves lanceolate; apex acuminate 285

285 Plants stipitate and dendroid-frondose; primary stem creeping *(284:)* 286
285: Plants erect but scarcely or not at all branched; primary stem creeping or not 287

286 Peristome double *(285)* .... **Cyrtopus**
286: Peristome single (exostome only) .... **Bescherellia**

287 Leaf margin entire to singly serrate; plants with a primary creeping stem *(285:)* .... **Echinodium**
287: Leaf margin doubly serrate; plants without a primary creeping stem .... **PYRRHOBRYUM** (p. 359)

288 Plants complanate-foliate *(283:)* 289
288: Plants terete-foliate 297

289 Leaves in 2 rows *(288)* .... **RHIZOGONIUM** (p. 364)
289: Leaves in several rows all around the stem 290

290 Plants stipitate *(289:)* 291
290: Plants not stipitate 294

291 Leaf margin with large multicellular teeth *(290)* ....**Homaliodendron**
291: Leaf margin entire or serrate with unicellular teeth 292

292 Leaves caducous; stems naked *(291:)*..**Caduciella**
292: Leaves not caducous; stems leafy 293

293 Capsule short-exserted *(292:)*...**Himantocladium**
293: Capsule long-exserted ....**Thamnobryum**

294 Costa percurrent or ending only 1 or 2 cells below the leaf apex; leaf margin crenulate *(290:)* ....**Bryobrothera**
294: Costa ending well below the leaf apex; leaf margin entire or strongly toothed............................. 295

295 Alar cells somewhat differentiated, quadrate; calyptra cucullate *(294:)* ....**Pendulothecium**
295: Alar cells not differentiated; calyptra mitrate 296

296 Costa forked above; leaf margin usually toothed; calyptra naked *(295:)*......................**Achrophyllum**
296: Costa not forked above; leaf margin entire; calyptra hairy .... **Distichophyllum**

297 Plants growing on rocks in streams *(288:)* 298
297: Plants growing in drier habitats.. 299

298 Plants slender; costa occupying c. one-third the width of the leaf base *(297)* ....**Touwia**
298: Plants moderately robust; costa occupying less than one-fifth the width of the leaf base ....**Dendrocryphaea**

299 Vegetative leaf length: width ratio c. 2: 1 or less *(297:)* 300
299: Vegetative leaf length: width ratio c. 3: 1 or more... 303

300 All stems ±creeping *(299)*.. **“Austropseudoleskea”**
300: Secondary stems erect to ascending 301

301 Sporophytes terminal on stems and short lateral branches; peristome single (exostome only) *(300:)* ....**Schoenobryum**
301: Sporophytes lateral; peristome double 302

302 Leaf apex obtuse; calyptra mitrate *(301)* .... **Cyptodon**
302: Leaf apex abruptly short-acuminate; calyptra cucullate... **Forsstroemia**

303 Laminal cells rhomboidal, c. 2: 1; capsule immersed in large sheathing perichaetial leaves *(299:)*.......... ....**Cryphaea**
303: Laminal cells rounded to quadrate, c. 1: 1; capsule exserted from only slightly differentiated perichaetial leaves.. 304

304 Leaves oblong; apex mucronate; upper laminal cells subquadrate in obliquely spreading rows; plants red-brown; calyptra lobed at base, not plicate *(303:)* .... **SCHLOTHEIMIA** (p. 225)
304: Leaves lanceolate to ligulate; apex acuminate to acute or rarely mucronate; upper laminal cells in vertical rows; plants chestnut-brown; calyptra slit at base and plicate... ....**MACROMITRIUM** (p. 191)

305 Plants stipitate from a creeping primary stem *(278:)* 306
305: Plants not stipitate; primary and secondary stems similar 314

306 Costa percurrent or ending in the apex *(305)*.. 307
306: Costa ending well below the apex 311

307 Plants umbellate to asymmetrically dendroid; on soil or soil-covered rocks *(306)*...........**Hypnodendron**
307: Plants frondose to sparsely pinnately branched; usually epiphytic 308

308 Leaves plicate *(307:)* .... **Pterobryon**
308: Leaves not plicate.. 309

309 Plants less than 5 cm tall; leaf apex abruptly piliferous *(308:)*...................................... **Muellerobryum**
309: Plants more than 5 cm tall; leaf apex gradually acuminate... 310

310 Leaves appearing bordered because the marginal or intramarginal cells are thicker than other laminal cells; capsule short-exserted and smooth *(309)* ....**Pterobryella**
310: Leaves not appearing bordered; capsule long-exserted and furrowed............................**Braithwaitea**

311 Leaves auriculate *(306:)* .... **Calyptothecium**
311: Leaves not auriculate 312

312 Leaf margin conspicuously serrulate; costa apex projecting as a spine *(311:)* .... **Eurhynchium**
312: Leaf margin ±entire; costa apex not projecting as a spine 313

313 Plants forming dense erect turfs, matted with tomentum, almost always on soil; leaf apex acuminate to piliferous *(312:)* .... **Lepyrodon**
313: Plants forming loose mats of projecting secondary stems, not tomentose, epiphytic; leaf apex short-acuminate .... **Forsstroemia**

314 Stem leaves falcate-secund *(305:)* 315
314: Stem leaves straight 318

315 Leaves plicate *(314)* 316
315: Leaves not plicate 317

316 Leaves shorter than 1.5 mm; seta papillose *(315)* .... **Brachythecium**
316: Leaves longer than 2 mm; seta smooth .... **Sanionia**

317 Stems branched in one plane *(315:)* .... **Drepanocladus**
317: Stems branched radially .... **Warnstorfia**

318 Leaves broadly ovate to elliptical, deeply concave; apex sometimes abruptly apiculate *(314:)* 319
318: Leaves lanceolate to ovate, plane to weakly concave; apex acute to acuminate 321

319 Alar cells small, quadrate, firm-walled, poorly differentiated; leaf apex abruptly reflexed and apiculate *(318)* .... **Pseudoscleropodium**
319: Alar cells large, rounded, inflated, in decurrent groups; leaf apex blunt 320

320 Plants pale green or yellow-green; stem leaf apex rounded; leaf-borne rhizoids common *(319:)* .... **Straminergon**
320: Plants often reddish; stem leaf apex usually apiculate; leaf-borne rhizoids rare .... **Warnstorfia**

321 Leaves plicate *(318:)* 322
321: Leaves not plicate 323

322 Branches curved-ascending when dry *(321)* .... **Homalothecium**
322: Branches prostrate when dry .... **Brachythecium**

323 Branch leaves, especially immature ones, strongly inrolled and thus appearing tubular *(321:)* .... **Scorpiurium**
323: Branch leaves various but never inrolled or appearing tubular 324

324 Laminal cells 6: 1 or shorter *(323:)* 325
324: Laminal cells 8: 1 or longer 332

325 Plants tufted, with simple erect stems; leaves 2–3 mm long *(324)* .... **GONIOBRYUM** (p. 355)
325: Plants matted, with branched prostrate (rarely erect) stems; leaves shorter than 2 mm 326

326 Alar cells well developed and in concave groups; paraphyllia usually present; branch leaves often ±falcate *(325:)* .... **Cratoneuron**
326: Alar cells poorly differentiated or, if well developed, not in concave groups; paraphyllia absent; branch leaves straight 327

327 Costa extending into the leaf apex; leaf margin entire or nearly so *(326:)* 328
327: Costa ending well below the leaf apex; leaf margin entire or serrulate 329

328 Plants on soil or rotting wood; exostome teeth striate *(327)* .... **Amblystegium**
328: Plants on bark; exostome teeth papillose .... **Anacamptodon**

329 Leaf margin entire; plants growing on rocks *(327:)* .... **Ischyrodon**
329: Leaf margin serrulate; plants growing on tree trunks 330

330 Peristome single; walls of exothecial cells wavy; plants common *(329:)* .... **Fabronia**
330: Peristome double; walls of exothecial cells straight; plants rare 331

331 Leaves lanceolate; exostome teeth papillose *(330:)* .... **Schwetschkea**
331: Leaves ovate; exostome teeth striate .... **Helicodontium**

332 Leaf apex cucullate and obtuse to minutely apiculate; leaves ovate-oblong *(324:)* 333
332: Leaf apex flat and acute to acuminate; leaves lanceolate to ovate-cordate 334

333 Plants pale green or yellow-green; stem leaf apex rounded; leaf-borne rhizoids common *(332)* .... **Straminergon**
333: Plants often reddish; stem leaf apex usually apiculate; leaf-borne rhizoids rare .... **Warnstorfia**

334 Leaf apex channelled; base concave; insertion narrow *(332:)* .... **Campyliadelphus**
334: Leaf apex not channelled; base not concave or the insertion not narrow 335

335 Apical cells of branch leaves noticeably shorter than mid-leaf cells *(334:)* 336
335: Apical cells of branch leaves not shorter than mid-leaf cells 337

336 Plants growing on periodically inundated rocks, dull dark green; stem leaf apex blunt *(335)* .... **Platyhypnidium**
336: Plants growing on various substrata in drier habitats; green to yellow-green or brownish green; stem leaf apex acuminate .... **Eurhynchium**

337 Plants with sporophytes *(335:)* 338
337: Plants lacking sporophytes 342

338 Operculum conical *(337)* 339
338: Operculum rostrate 340

339 Plants complanate-foliate; capsule long-cylindrical and strongly arcuate *(338)* .... **Leptodictyum**
339: Plants terete- to somewhat complanate-secund-foliate; capsule short-cylindrical and only slightly arcuate .... **Brachythecium**

340 Seta rough; plants small; leaves lanceolate *(338:)* .... **Rhynchostegiella**
340: Seta smooth; plants medium-sized; leaves ovate 341

341 Capsule erect and symmetrical *(340:)* .... **Eriodon**
341: Capsule inclined and asymmetrical .... **Rhynchostegium**

342 Plants complanate-foliate *(337:)* 343
342: Plants terete-foliate 345

343 Leaf margin entire; plants of wet habitats *(342)* .... **Leptodictyum**
343: Leaf margin serrulate; plants of drier habitats 344

344 Plants epiphytic; capsule erect *(343:)* .... **Eriodon**
344: Plants on soil, rotting wood or rock; capsule inclined .... **Rhynchostegium**

345 Plants small, usually epiphytic; leaves shorter than 1 mm *(342:)* .... **Rhynchostegiella**
345: Plants medium-sized to moderately robust, on soil; leaves usually longer than 1 mm 346

346 Stems and branches strongly curved when dry *(345:)* .... **Scleropodium**
346: Stems and branches not or only slightly curved when dry .... **Brachythecium**

347 Leaf hairpoint conspicuous, piliferous, c. as long as the lamina *(272:)* .... **LEPTOSTOMUM** (p. 350)
347: Leaf hairpoint lacking or much shorter than the lamina 348

348 Plants minute, less than 4 mm tall, growing on soil *(347:)* 349
348: Plants larger, more than 5 mm tall or, if minute, gregarious on rock; otherwise growing on various substrata 362

349 Capsule cleistocarpous *(348)* 350
349: Capsule operculate 355

350 Costa ending in mid-leaf; laminal cells thin-walled *(349)* 351
350: Costa ending near the leaf apex; laminal cells firm-walled 352

351 Leaves oblanceolate, spathulate or obovate; capsule short-apiculate; spores less than 50 µm diam. *(350)* .... **Physcomitrella**
351: Leaves linear to linear-lanceolate; capsule not apiculate; spores more than 100 µm diam. .... **ARCHIDIUM** (p. 147)

352 Spores usually only 16–32 per capsule, more than 100 µm diam. *(350:)* .... **ARCHIDIUM** (p. 147)
352: Spores many per capsule, less than 50 µm diam. 353

353 Vegetative leaves subulate; calyptra mitrate; capsule neck strongly differentiated *(352:)* .... **Bruchia**
353: Vegetative leaves acute to acuminate; calyptra cucullate; capsule neck not strongly differentiated.... 354

354 Protonemata persistent; costa without stereids *(353:)* .... **EPHEMERUM** (p. 163)
354: Protonemata not persistent; costa with 2 central stereid bands in cross-section .... **Pleuridium**

355 Capsule neck strongly differentiated, usually about as long as or longer than the urn *(349:)* 356
355: Capsule neck scarcely differentiated 357

356 Leaves subulate from an abruptly expanded base *(355)* .... **Trematodon**
356: Leaves lanceolate to ovate from a gradually expanded base .... **Entosthodon**

357 Capsule immersed or protruding on an arcuate seta *(377:)* 358
357: Capsule exserted 360

358 Calyptra plicate, large, covering the entire capsule *(357)* .... **Goniomitrium**
358: Calyptra not plicate, smaller, covering only the capsule apex 359

359 Seta short, often arcuate; vaginula long-cylindrical; foot dagger-shaped; laminal cells usually firm-walled; costa usually distinct *(358:)* .... **Eccremidium**
359: Seta absent; vaginula short-cupulate; foot subglobose; laminal cells lax; costa rudimentary or absent .... **NANOMITRIOPSIS** (p. 166)

360 Calyptra mitrate; operculum conical or rostrate *(357:)* .... **Physcomitrium**
360: Calyptra cucullate; operculum flat to short-conical 361

361 Capsule sulcate when dry; annulus compound and revoluble *(360)* .... **Funaria**
361: Capsule smooth or wrinkled when dry; annulus neither compound nor revoluble .... **Entosthodon**

362 Costa very broad, occupying (1/4–) 1/3–1/2 of the leaf base *(348:)* 363
362: Costa narrower, occupying less than 1/4 of the leaf base 367

363 Alar cells scarcely differentiated *(362)* 364
363: Alar cells well differentiated 366

364 Leaves subulate *(363)* .... **Campylopus**
364: Leaves oblong-lingulate to broadly lanceolate 365

365 Stems with copious red tomentum; seta long; capsule peristomate *(364:)* .... **MEESIA** (p. 185)
365: Stems lacking red tomentum; seta very short to absent; capsule cleistocarpous... **ARCHIDIUM** (p. 147)

366 Inner basal cells of leaf not conspicuously differentiated along the costa; capsule furrowed; annulus compound; calyptra usually fringed *(363:)* .... **Campylopus**
366: Inner basal cells of leaf pale, enlarged and broadly rectangular, extending upward along the costa; capsule smooth, exannulate; calyptra not fringed .... **Dicranodontium**

367 Erect stems arising from a creeping primary stem *(362:)* 368
367: Erect stems independent, not arising from a creeping primary stem 369

368 Plants in spongy turfs with dense tomentum; leaf margin not thickened; costa ending well short of the leaf apex *(367)* .... **Lepyrodon**
368: Plants in rigid loose mats with ascending scarcely branched stems and sparse tomentum; leaf margin thickened; costa percurrent to excurrent .... **Echinodium**

369 Leaves linear or subulate from a gradually narrowed broader base *(367:)* 370
369: Leaves obovate, ovate or lanceolate; apex obtuse, acute or short-acuminate, sometimes with the costa abruptly excurrent 390

370 Alar cells not or scarcely differentiated, similar to the lower laminal cells *(369)* 371
370: Alar cells differentiated 383

371 Leaf margin with double teeth *(370)* .... **PYRRHOBRYUM** (p. 359)
371: Leaf margin entire or with only single teeth 372

372 Capsule immersed *(371:)* 373
372: Capsule exserted 374

373 Capsule peristomate and terminal *(372)* .... **Garckea**
373: Capsule cleistocarpous and usually axillary .... **ARCHIDIUM** (p. 147)

374 Plants minute, growing on rock; capsule ovoid; stems less than 3 mm long; seta less than 3 mm long *(372:)* 375
374: Plants small, growing on soil; capsule elliptical to cylindrical; stems usually more than 3 mm long; seta usually more than 3 mm long 376

375 Capsule ribbed; seta cygneous; calyptra large and mitrate *(374)* .... **Brachydontium**
375: Capsule smooth; seta straight; calyptra small and cucullate .... **Seligeria**

376 Leaves linear; upper laminal cells linear, c. 10: 1 and extending to the leaf apex *(374:)* 377
376: Leaves subulate; upper laminal cells ±isodiametric to rectangular; costa filling the subula or nearly so 379

377 Capsule long-cylindrical; peristome single, with spiral thickenings *(376)* .... **Wilsoniella**
377: Capsule pyriform to oval-cylindrical; peristome double, with papillose ornamentation 378

378 Capsule inclined, pyriform; endostome with a high basal membrane *(377:)* .... **LEPTOBRYUM** (p. 182)
378: Capsule erect to slightly inclined, oval-cylindrical; endostome with a very low basal membrane .... **ORTHODONTIUM** (p. 271)

379 Capsule neck well differentiated, as long as or longer than the urn *(376:)* .... **Trematodon**
379: Capsule neck scarcely differentiated 380

380 Peristome teeth linear, divided into 2 filiform terete segments; capsule long-cylindrical *(379:)* 381
380: Peristome teeth lanceolate, undivided or irregularly bifid and flat; capsule ovoid 382

381 Plants bluish glaucous *(380)* .... **Saelania**
381: Plants green, not glaucous .... **Ditrichum**

382 Peristome teeth vertically pitted below *(380:)* .... **Dicranella**
382: Peristome teeth smooth to papillose below .... **Microdus**

383 Perichaetial leaves long-sheathing, tubular, extending well up the seta; upper leaf margin bistratose *(370:)* .... **Holomitrium**
383: Perichaetial leaves not sheathing or only shortly so, concave to plane, not extending much beyond the vegetative leaves; upper leaf margin unistratose 384

384 Capsule less than 1.5 mm long, ovoid, elliptical or hemispherical; seta usually flexuose to cygneous and short *(383:)* 385
384: Capsule (1–) 2–3.5 mm long, cylindrical; seta straight and long 387

385 Capsule sulcate *(384)* .... **Campylopodium**
385: Capsule smooth 386

386 Alar cells well differentiated; peristome teeth smooth *(385:)* .... **Blindia**
386: Alar cells not differentiated; peristome teeth coarsely papillose .... **Verrucidens**

387 Leaves crisped when dry *(384:)* .... **Dicranoweisia**
387: Leaves falcate when dry 388

388 Peristome teeth papillose; plants small; stems less than 10 mm long *(387:)* .... **Holodontium**
388: Peristome teeth pitted-striolate; plants small to large; stems more than 10 mm long 389

389 Plants dioicous, usually growing on soil or epiphytic at low elevations; costa with 2 stereid bands or, if stereids lacking, the plants very large with leaves 5–8 mm long *(388:)* .... **Dicranum**
389: Plants autoicous, growing on alpine granitic rock; costal stereids lacking or few and poorly differentiated; leaves less than 5 mm long .... **Kiaeria**

390 Leaves broadly involute when dry; laminal cells asymmetrical, flat below and bulging above *(369:)* .... **Hyophila**
390: Leaves plane or variously contorted when dry but not involute; laminal cells symmetrical 391

391 Costa ending well below the leaf apex *(390:)*........ 392
391: Costa ending near the leaf apex to excurrent........ 395

392 Laminal cells 2–4: 1 *(391)*........ 393
392: Laminal cells isodiametric........ 394

393 Plants glossy and bright green to whitish; leaf apex obtuse to acute; capsule cylindrical to pyriform *(392)* .... **BRYUM** (p. 280)
393: Plants dull and glaucous green; leaf apex acute to acuminate; capsule globose .. **PHILONOTIS** (p. 265)

394 Leaves more than 4 mm long, ±bordered at base; laminal cells more than 30 µm diam. *(392:)* .... **Orthomnion**
394: Leaves less than 1 mm long, not bordered; laminal cells less than 30 µm diam. .**MITTENIA** (p. 369)

395 Upper laminal cells ±isodiametric, 1: 1, rounded, quadrate or short-hexagonal *(391:)* 396
395: Upper laminal cells longer, 2–19: 1, rectangular, long-hexagonal or linear 410

396 Plants bearing filamentous or cylindrical to elliptical propagula in the leaf axils *(395)* 397
396: Plants lacking propagula in the leaf axils, but sometimes producing rhizoidal tubers 399

397 Propagula filamentous, 6–12 or more cells long; costa excurrent in a stout cusp *(396)* .... **LEPTOTHECA** (p. 356)
397: Propagula cylindrical to elliptical, less than 8 cells long; costa subpercurrent to apiculate 398

398 Costa with 2 stereid bands in cross-section *(397:)*........ **Barbula**
398: Costa lacking stereids in cross-section .... **ZYGODON** (p. 237)

399 Leaves strongly 3-ranked *(396:)* .... **MEESIA** (p. 185)
399: Leaves not in conspicuous rows 400

400 Leaves strongly toothed *(399:)* 401
400: Leaves entire to minutely serrulate 402

401 Leaves curled when dry; upper laminal cells 6–8 µm diam.; capsule erect *(400)*........ **Ptychomitrium**
401: Leaves flat when dry; upper laminal cells more than 10 µm diam.; capsule inclined .... **RHIZOGONIUM** (p. 364)

402 Plants simple or only sparsely branched, gregarious or turf-forming, growing on soil *(400:)* 403
402: Plants branched, tufted; growing on bark or rock........ 406

403 Leaf apex obtuse to subacute *(402)*........ **Barbula**
403: Leaf apex short-acuminate to acute........ 404

404 Leaves lanceolate; laminal cells less than 10 µm diam.; leaf margin revolute; capsule inclined and furrowed *(403:)* .... **Ceratodon**
404: Leaves oblong to spathulate; laminal cells more than 15 µm diam.; leaf margin plane or recurved at the base; capsule erect and smooth 405

405 Costa with 1 stereid band in cross-section; plants autoicous and frequently fertile; capsule exserted and operculate *(404:)* .... **Pottia**
405: Costa lacking stereids or very weakly developed in cross-section; plants dioicous (but not fertile in Australia); capsule immersed and cleistocarpous .... **Chenia**

406 Plants growing on tree trunks; calyptra hairy; stomata immersed *(402:)*...**STONEOBRYUM** (p. 227)
406: Plants growing on rock; calyptra naked; stomata superficial 407

407 Leaves linear-lanceolate; laminal cells with minute elliptical cuticular ornamentation; capsule ribbed; peristome absent *(406:)*........ **Amphidium**
407: Leaves lanceolate to ovate; laminal cells smooth; capsule usually smooth; peristome single or rarely absent 408

408 Calyptra large, mitrate-campanulate and plicate; leaves never hairpointed *(407:)* ..... **Ptychomitrium**
408: Calyptra small, mitrate or cucullate, not plicate; leaves sometimes hairpointed........ 409

409 Capsule systylious and immersed; perichaetial leaves well differentiated *(408:)*........ **Schistidium**
409: Capsule not systylious, immersed to exserted; perichaetial leaves not or scarcely differentiated .... **Grimmia**

410 Costa occupying a quarter or more of the width of the leaf base *(395:)* .... **MEESIA** (p. 185)

410: Costa occupying less than a sixth of the width of the leaf base 411

411 Upper laminal cells short-rectangular, thin-walled; peristome with endostome segments opposite the exostome teeth *(410:)* 412

411: Upper laminal cells long-hexagonal, usually firm-walled; peristome with endostome segments alternating with the exostome teeth 414

412 Capsule peristomate and symmetrical; hypophysis conspicuous and at least half the length of the urn, sometimes brightly coloured; leaves sometimes strongly toothed *(411)*...... **TAYLORIA** (p. 173)

412: Capsule asymmetrical or, if symmetrical, not peristomate; hypophysis usually not conspicuous; leaves usually serrulate 413

413 Capsule sulcate when dry; annulus compound and revoluble *(412:)* .... **Funaria**

413: Capsule smooth or wrinkled when dry; annulus neither compound nor revoluble .... **Entosthodon**

414 Mid-leaf laminal cells (6–) 8–12: 1; marginal cells not much longer; leaves usually lanceolate*(411:)* 415

414: Mid-leaf laminal cells 2–6: 1; marginal cells usually somewhat longer; leaves usually ovate 416

415 Capsule pendent; peristome double and well developed; sporophyte apical *(414)* .... **Pohlia**

415: Capsule erect to inclined; peristome double or single but, if double, the exostome reduced; sporophyte basal .... **Schizymenium**

416 Costa subpercurrent, ending 3–10 cells below the leaf apex *(414:)* 417

416: Costa percurrent to excurrent 421

417 Leaf apex acute *(416)* 418

417: Leaf apex rounded-obtuse 420

418 Plants silvery or whitish *(417)* .... **BRYUM** (p. 280)

418: Plants greenish or yellow-green 419

419 Sporophytes terminal; leaf margin indistinctly bordered *(418:)* .... **BRYUM** (p. 280)

419: Sporophytes basal; leaf margin not bordered .... **GONIOBRYUM** (p. 355)

420 Stem 5–15 mm tall; cells of upper leaf margin shorter than those at mid-leaf; archegonia single and axillary *(417:)* ....**SPLACHNOBRYUM** (p. 161)

420: Stem 20–60 mm tall; cells of upper leaf margin longer than those at mid-leaf; archegonia clustered and terminal .... **OCHIOBRYUM** (p. 320)

421 Plants usually with asexual propagula; capsule erect to suberect *(416:)*....... **GEMMABRYUM** (p. 287)

421: Plants usually without asexual propagula; capsule usually inclined 422

422 Plants delicate, flaccid, pale green and red-tinged; leaf apex acute; endostomial cilia absent *(421:)* ... . **PLAGIOBRYUM** (p. 322)

422: Plants sturdy, not flaccid, bright green; leaf apex short-acuminate; endostome with cilia 423

423 Stems julaceous; upper and median laminal cells elongate-rhomboidal to vermicular ..**BRYUM** (p. 280)

423: Stems never julaceous; upper and median laminal cells rhomboidal .... **PTYCHOSTOMUM** (p. 323)

SPHAGNACEAE

Rodney D. Seppelt[1]

Sphagnaceae Dumort., *Ann. Fam. Pl.* 68 (1829).

Type: *Sphagnum* L.

Dioicous or autoicous. Plants robust, gregarious, developing from a thallose protonema. Stems primarily erect, simple or sparingly branched, lacking a central strand, but usually with a distinct hyalodermis (outer cortex) 1–4 cells thick overlaying a scleroderm (wood cylinder) of smaller thick-walled and often coloured cells; stems bearing clusters of branches arranged in fascicles at ±regular intervals; terminal branches crowded as a capitulum. Branches uniform or dimorphic: spreading branches at c. 90° to stem; and thinner ±pendent branches with smaller leaves lying against the stem; branches with a single-layered hyalodermis with cortical cells uniform or dimorphic: 1–4 “retort cells”, protuberant above, with a subterminal pore, distinct from the remaining cells which are usually imperforate. Stem leaves usually differing in form from branch leaves and more remotely arranged; spiral thickenings and pores fewer than in branch leaves, sometimes absent. Branch leaves unistratose, composed of two cell types: large empty hyaline cells usually with annular or spiral strengthening fibrils and with one or more large pores; and an interposing network of narrow elongate photosynthetic cells. Perigonia forming part of an otherwise unmodified branch; antheridia globose. Perichaetia borne on very short specialised branches at insertion of a fascicle, becoming greatly enlarged after fertilisation. Setae remaining very short. Capsules globose, raised at maturity on a stalk-like extension (pseudopodium) of the gametophyte, lacking a peristome, dehiscing by explosive discharge of the shallowly convex lid. Spores tetrahedral, 22–42 µm diam.; distal face smooth to strongly papillose; proximal faces ±smooth, separated by a distinct triradiate ridge.

This monotypic family of c. 250 species is found in all continents except Antarctica. It occurs from near sea level to altitudes above 3000 m, mainly in wet, nutrient-poor, acidic wetland and mire habitats. Six species are known from Australia.

C.Warnstorf, Sphagnales – Sphagnaceae, *Pflanzenreich* 51: 1–546 (1911); W.W.Watts, The *Sphagna* of Australia and Tasmania, *Proc. Linn. Soc. New South Wales* 37: 383–389 (1912); A.L.Andrews, Studies in the Warnstorf *Sphagnum* herbarium. V. The group *Cuspidata* in South America, *Bryologist* 52: 124–130 (1949); J.H.Willis, Systematic notes on Victorian mosses. 2, *Victorian Naturalist* 70: 55–57 (1953); J.H.Willis, Some further notes on *Sphagnum*, *Victorian Naturalist* 71: 189–190 (1955); G.G.Smith, *Sphagnum subsecundum* in Western Australia, *W. Australian Naturalist* 11: 56–59 (1969); A.Eddy, Sphagnales of tropical Asia, *Bull. Brit. Mus. (Nat. Hist.), Bot.* 5: 359–445 (1977); H.[A.]Crum, Sphagnopsida, Sphagnaceae, *North American Flora*, ser. II, 11: i–ii, 1–180 (1984); H.Streimann, & J.Curnow, *Catalogue of Mosses of Australia and its External Territories*. Australian Flora and Fauna Series No. 10. AGPS, Canberra (1989); P.J.Dalton, R.D.Seppelt & A.M.Buchanan, An annotated checklist of Tasmanian mosses, *in* M.R.Banks *et al.* (eds), Aspects of Tasmanian Botany – A tribute to Winifred Curtis, 15–31. Royal Society of Tasmania, Hobart (1991); A.J.Fife, A synopsis of New Zealand *Sphagna*, with a description of *S. simplex* sp. nov., *New Zealand J. Bot.* 34: 309–328 (1996); H.A.Crum & R.D.Seppelt, *Sphagnum leucobryoides* reconsidered, *Contr. Univ. Michigan Herb*. 22: 29–31 (1999); R.D.Seppelt & H.[A.]Crum, *Sphagnum fuscovinosum*, a new species from Australia, *Contr. Univ. Michigan Herb.* 22: 131–134 (1999); R.D.Seppelt, The Sphagnopsida (Sphagnaceae; Ambuchaniaceae) in Australia, *Hikobia* 13: 163–183 (2000).

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SPHAGNUM

Sphagnum L., *Sp. Pl.* 2: 1106 (1753); from a Greek root referring to an unknown plant.

Lecto: *S. palustre* L.

Description as for the family.

Branch leaf outline is useful in delimiting some sections of *Sphagnum*, but it is rarely of value in identifying species. Anatomical features of branch leaves, including leucocysts (hyaline cells), chlorocysts (pigmented or chlorophyllous cells) and pores, provide most of the key characters for the recognition of species and sections. Leaves of the pendent or vestigial branches can be substantially modified, and they lack features of normal branch leaves. Stem leaf morphology is of limited taxonomic use.

Taxonomically useful characters also include the type of pore (ringed or unringed), pore distribution pattern relative to the leaf surfaces (adaxial and abaxial) and, to a lesser extent, pore diameter rather than pore frequency. However, their usefulness varies greatly between sections and, for example, considerable variation in pore number can be found in some taxa, particularly in sect. *Subsecunda.*

Anatomical details of leaves, particularly pores and the presence or absence of pseudopores in the leucocysts, are best observed when stained with an 0.5% aqueous crystal violet or Toluidine Blue solution. Leaf, stem and branch sections are also essential for accurate identification. The sectional shape, lateral ornamentation, position and exposure of the chlorophyllose cells relative to the adaxial and abaxial leaf surfaces can only be observed in thin sections of the leaves.

The number of species within the genus depends largely on interpretation of ‘species’, and many ecotypic variants have historically been described as distinct species, subspecies and varieties. Within the genus there are a number of well-defined groups which, in common with most modern treatments, are here referred to as sections.

The bryological literature includes numerous erroneous reports of *Sphagnum* spp. from Australia, as well as a large number of newly described taxa that are now regarded as synonyms. Watts & Whitelegge (*Proc. Linn. New South Wales* 27 (Suppl.): 1–90, 1902) listed 30 species for Australia and Tasmania, while Warnstorf (1911) documented 23 species from mainland Australia and 9 from Tasmania. Watts (1912) reviewed the genus in Australia and noted 23 species for the mainland with 6 species found only in Tasmania. Andrews (1949) and Willis (1953) reduced a number of Australian taxa to synonymy, but recent studies have indicated that considerable nomenclatural confusion remains, with some of these taxa being incorrectly assigned. This is particularly true of sect. *Subsecunda*, where much Australian material has been referred incorrectly to *S. subsecundum* and *S. cymbifolioides*, and also includes the *S. molliculum*-*S. novozelandicum* complex in which there may well be additional taxa not included here.

1 Plants without clearly differentiated stems and branches; branches, if present, not in fascicles .... **5. S. fuscovinosum**

1: Plants with clearly differentiated stems and branches; branches borne in fascicles on the stem 2

2 Cortical cells of stems and branches commonly fibrillose (sometimes almost absent in *S. perichaetiale*); branch leaves broad, cucullate, roughened at the back (abaxial side) of the broad apex and denticulate along marginal resorption furrow; hyaline cells of branch leaves with pores in 2s and 3s at adjacent cell angles, at least on adaxial surface *(1:)* 3

2: Cortical cells of stems and branches never fibrillose; branch leaves tapered to a narrow truncate apex, or less tapered and broadly truncate, usually entire, except across apex; mostly without a resorption furrow; hyaline cells of branch leaves rarely with pores in 2s or 3s at adjacent cell angles, at least on abaxial surface 4

3 Adaxial surface pores of branch leaf hyaline cells absent or rare; abaxial surface pores large, 2–8, ringed, often in 3s at basal angles of cells *(2)* .... **1. S. cristatum**

3: Adaxial surface pores of branch leaf hyaline cells absent or with few (1–4) simple pores scattered along commissures; abaxial surface pores in mid-leaf arranged at conjunction of basal and lateral angles of adjacent cells, forming pseudolacunae, with no or few additional pores............. **2. S. perichaetiale**

4 Stem cortical cells in 1 or 2 layers *(2:)*...5

4: Stem cortical cells in 3 (sometimes more) layers 6

5 Stem cortical cells predominantly in 1 layer; hyaline cells of branch leaves with numerous pores abaxially, few adaxially; chlorophyllose cells narrowly ellipsoidal or narrowly rectangular in section, exposed equally on both surfaces of leaf *(4)* ....**6. S. novozelandicum**

5: Stem cortical cells predominantly in 2 layers; hyaline cells of branch leaves with very few pores abaxially or adaxially; chlorophyllose cells triangular in section, exposed abaxially ..... **4. S. falcatulum**

6 Hyaline cells of stem cortex fibrillose and porose *(4:)*... **1. S. cristatum**

6: Hyaline cells of stem cortex efibrillose and porose ....**3. S. australe**

Sect. 1. Sphagnum

Sphagnum L. sect. **Sphagnum**

Type: *S. palustre* L.

Dioicous. Stem cortical cells in 3 or 4 layers, large, thin-walled, hyaline, fibrillose, porose with 1 or more pores on outer surface. Branches stout, tumid; branch cortical cells similar to those of stem, but typically uniporose. Branch leaves imbricate, broadly ovate, deeply concave and cucullate, roughened at abaxial surface near apex by resorption of hyaline cells, narrowly bordered by partial resorption of marginal cells; adaxial surface pores of hyaline cells of branch leaves numerous, large, generally elliptic, at ends and corners and often along commissures, commonly in 3s at adjacent cell corners; abaxial surface pores fewer; chlorophyllose cells variable in shape (elliptic to equilateral-triangular or, rarely, ±trapezoidal) and exposure (from entirely immersed to exposed only on adaxial surface, or more broadly exposed on adaxial than on abaxial surface). Stem leaves small, almost flat, lingulate, finely fringed.

Two species occur in Australia.

1. Sphagnum cristatum Hampe, *Linnaea* 38: 661 (1874)

T: Mt Kosciuszko, [N.S.W.], *F.Mueller*; lecto: BM-Hampe, *fide* A.J.Fife, *New Zealand J. Bot.* 34: 312 (1996).

Sphagnum subbicolor Hampe, *Flora* 63: 440 (1880). T: Mt Warning, [N.S.W.], *W.Guilfoyle s.n.*; holo: NY.

Sphagnum pachycladum Müll.Hal., *Fragm.* 11 (Suppl.): 108 (1881), *nom. nud.*

Sphagnum wilcoxii Müll.Hal., *Flora* 70: 407 (1887). T: Clarence R., N.S.W., Nov. 1875, *Wilcox*; holo: MEL.

Sphagnum leionotum Müll.Hal., *Flora* 70: 408 (1887). T: Table Mtn, South Africa, 1877, *Spielhaus*; *n.v.*

Sphagnum whiteleggei Müll.Hal., *Flora* 70: 408 (1887). T: Lawson, Blue Mountains, N.S.W., 1884, *T.Whitelegge*; holo: *n.v.*; iso: NSW?

Sphagnum australe Schimp., *in* C.Warnstorf, *Bot. Gaz. (Crawfordsville)* 15: 250 (1890), *nom. illeg.* (later homonym).

Sphagnum cymbophyllum F.Muell., *in* C.Warnstorf, *Hedwigia* 30: 36 (1891), *nom. inval.* (in synon.).

Sphagnum maximum Warnst., *Hedwigia* 30: 160 (1891). T: New Zealand, *Kirk 8*; syn: BM?; Tasmania, *Scott 7*; syn: MEL? *n.v.*

Sphagnum grandifolium Warnst., *Bot. Centralbl.* 82: 8 (1900). T: Tyagarah Rd, Byron Bay, N.S.W., *W.W.Watts 3078*, *3081*, *3082*, *3083*; syn: H-BR.

Sphagnum decipiens Warnst., *Hedwigia* 47: 78 (1907). T: Govetts Leap, Blue Mountains, N.S.W., *W.W.Watts 6119*, *6120*, *6120a*, *6121*, *6123*, *6126a*, *6128*, *6130*, *6132*, *6133*, *6135*, *6137*, *6138*, *6142*, *6142a*, *6230*; syn: H-BR.

Sphagnum decipiens Warnst. var. *obovatum* Warnst., *Hedwigia* 47: 79 (1907). T: not located.

Sphagnum decipiens Warnst. var. *obovatum* Warnst. f. *squarrosulum* Warnst., *Hedwigia* 47: 79 (1907). T: Blue Mountains, N.S.W., *W.W.Watts 6119*, *6129*; syn: NSW.

Sphagnum decipiens Warnst. var. *obovatum* Warnst. f. *anocladum* Warnst., *Hedwigia* 47: 79 (1907). T: Blue Mountains, N.S.W., *W.W.Watts 6120a*, *6121*, *6126a*, *6130*, *6132*, *6133*, *6135*, *6137*, *6138*, *6230*; syn: H-BR.?; isosyn (of *6138*, *6230*): NSW.

Sphagnum decipiens Warnst. var. *rotundatum* Warnst., *Hedwigia* 47: 79 (1907). T: Blue Mountains, N.S.W., *W.W.Watts 6123*, *6142*, *6142a*; syn: H-BR; isosyn: NSW.

Sphagnum wardellense Warnst., *Hedwigia* 47: 81 (1907). T: Richmond River, [N.S.W.], *Wardel*, (*Watts 5272*); holo: H-BR? *n.v.*

Sphagnum maximum Warnst. var. *squarrosulum* Warnst., *Pflanzenreich* 51: 459 (1911). T: Bellinger River, [N.S.W.], *Canon 2*; holo: H-BR.

Sphagnum grandifolium Warnst. var. *brachycladum* Warnst., *Pflanzenreich* 51: 484 (1911). T: *s. loc.*, N.S.W., *W.W.Watts 4202*, *4204*, *4205*, *4206*, *4243*, *4244*, *4245*; syn: H-BR.; isosyn (of *4202*, *4204*, *4205*): NSW.

Sphagnum grandifolium Warnst. var. *brachycladum* Warnst. f. *laxifolium* Warnst., *Pflanzenreich* 51: 484 (1911). T: *s. loc.*, N.S.W., *W.W.Watts 4208*; holo: H-BR? *n.v.*; iso: NSW.

Sphagnum grandifolium Warnst. var. *densum* Warnst., *Pflanzenreich* 51: 485 (1911). T: *s. loc.*, N.S.W., *W.W.Watts 3078*, *3081*, *4131*, *4134*, *4274*; syn: NSW.

Illustrations: K.W.Allison & J.Child, *Mosses of New Zealand* 30, pl. 3 (1971); R.D.Seppelt, *Hikobia* 13: 167, fig. 1 (2000).

Plants small to robust, pale green to brownish green, sometimes with a purplish brown colouration; capitulum not obscured by branches. Stem cortical cells in 3 or 4 layers surrounding a brown internal cylinder, fibrillose; outer layer with 1 or more irregularly arranged rounded to elliptic pores. Branches in fascicles of 4–5 (–6), 2 or 3 larger spreading branches and 2 or 3 pale slender pendent branches; branch cortical cells in 1 layer, ±uniform, strongly fibrillose, with or without a single pore at distal end. Branch leaves broadly ovate, concave, with cucullate and rounded apices, strongly roughened on abaxial surface near apex by cell wall resorption, serrulate above, bordered by 1 row of narrow cells; pores conspicuous under ×50 magnification; adaxial surface pores of hyaline cells absent or rare; abaxial surface pores large, 2–8, ringed, often in 3s at basal angles of cells; chlorophyllose cells narrowly elliptic in section (occasionally narrowly urceolate), narrowly exposed on both surfaces; commissural walls smooth. Stem leaves erect or pendent, lingulate; apex and margins narrowly eroded by resorption of hyaline cell walls; hyaline cells efibrillose to weakly fibrillose near the apex. Fig. 3, Plate 1.

Mainly subalpine in N.S.W., A.C.T., Vic. and Tas.; forms turfs and mounds. Also in New Zealand. Map 1.

N.S.W.: Gloucester Tops, *H.Streimann 1529* (CANB); Merritts Ck, Mt Kosciuszko, *H.Streimann 5360* (CANB). A.C.T.: Mt Gingera, *D.G.Catcheside 54.23* (AD). Vic.: L. Catani, Mt Buffalo, *D.G.Catcheside 69.238* (AD). Tas.: Mt Michael, *A.Moscal 13201* (HO).

2. Sphagnum perichaetiale Hampe, *Linnaea* 20: 66 (1847)

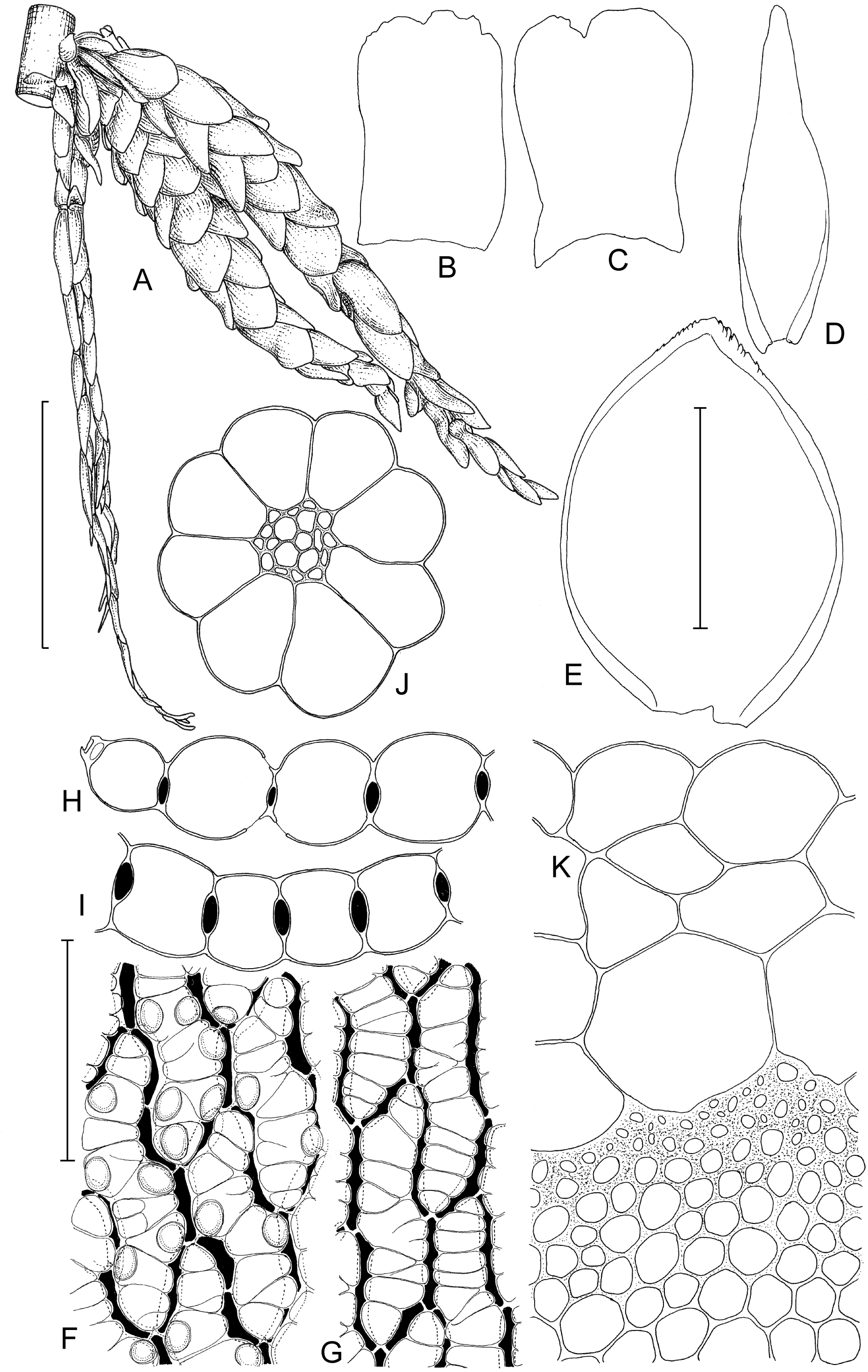
T: Brazil, *Beyrich s.n.*; holo: BM-Hampe.

Sphagnum beccarii Hampe, *Nuovo Giorn. Bot. Ital.* 4: 278 (1872). T: Sarawak, Borneo, [Malaysia], *Beccari 15*; holo: BM.

Sphagnum grandifolium Warnst., *Bot. Centralbl.* 82: 8 (1900). T: *s. loc.*, N.S.W., *W.W.Watts 3078*; holo: BM; iso: NSW.

Illustrations: A.Eddy, *Bull. Brit. Mus. (Nat. Hist.), Bot.* 5: 381, fig. 3; 382, fig. 4 (1977); R.D.Seppelt, *Hikobia* 13: 169, fig. 2 (2000).

Figure 3 (opposite). *Sphagnum cristatum*. **A**, Stem segment showing branch fascicle; **B**, **C**, Stem leaves; **D**, Pendent branch leaf; **E**, Divergent branch leaf; **F**, **G**, Abaxial (F) and adaxial (G) surfaces of mid-leaf cells of branch leaf; **H**, **I**, T.S. of divergent branch leaves; **J**, T.S. of branch; **K**, Part of T.S. of stem with 3–4 rows of cortical cells and the dense, dark outer part of the scleroderm (A–G, *D.H.Vitt 27634*, ALTA; H, I, *E.F.Constable s.n.*, AD 11708; J, K, *R.D.Seppelt 17600*, AAD). Scale bars: 5 mm for stem and branch fascicle; 1 mm for leaves; 100 µm for cells and sections. Drawn by R.D.Seppelt. Reproduced with permission from *Hikobia* 13: 167 (2000). © Hikobia Botanical Society.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Possibly dioicous, very rarely found fertile (not in Australia). Plants usually robust, yellowish brown to brownish green, sometimes with a dull reddish brown pigmentation, compact to lax. Stems with a well-developed cortex; cortical cells mostly 3-layered, with internal; end and external walls all with large pores; exposed outer wall of cortical cells with a single pore; without or with weakly to well-developed fibrillar thickenings. Branches in fascicles of 4 or 5 (occasionally 2 or 3), rather strongly dimorphic; spreading branches rather tumid, blunt or tapering distally; pendent branches strongly deflexed, pale, comparatively thin and attenuate; branch cortical cells uniform, of a single layer of large leucocysts, convex on outer and inner surfaces, some or all with a non-protuberant pore. Branch leaves erect-spreading, broadly ovate, concave, to 2 mm long, 1.0–1.5 mm wide; apex rounded, cucullate, scabrous abaxially due to projecting partially resorbed hyaline cells; border of 1 row of narrow cells, with a resorption furrow; leucocysts comparatively broad, 60–150 µm long, c. 25 µm wide; adaxial surface pores in mid-leaf usually lacking or with 1–4 simple pores scattered along commissures; abaxial surface pores in mid-leaf arranged at junction of basal and lateral angles of adjacent cells, forming pseudolacunae, with no or few additional pores; leucocysts, in section, plane to convex adaxially, strongly convex abaxially; chlorophyllose cells relatively narrow, urceolate to elliptic, exposed equally on both surfaces or more narrowly on abaxial surface. Stem leaves variable, erect or pendent, lingulate and almost efibrillose to strongly fibrillose and resembling branch leaves in morphology; apex typically broadly rounded, weakly bordered, variously eroded.

Occurs in N.T., Qld and N.S.W. Also in New Zealand (North Island), India, SE Asia, Malesia, Melanesia, Fiji, South America, the Caribbean, eastern U.S.A., southern Africa, Madagascar and Mauritius. Tropical to subtropical, favouring irrigated rocks and acidic, organic or inorganic substrata in open to semi-shaded, generally wetter habitats. Map 2.

N.T.: Twin Falls–Jim Jim Falls area, Kakadu Natl Park, *J.Russell-Smith 1225* (MEL). Qld: Cania Gorge Natl Park, near Monto, *I.G.Stone 21072* (MEL); Cania Gorge Natl Park, *I.G.Stone 22670* (MEL). N.S.W.: L. Medlow, *E.F.Constable M 11066* (NSW).

Eddy (1977) included 52 taxa in the synonymy of *S. perichaetiale*. In the Australian material examined the fibrillar thickenings of the stem cortical cells, a characteristic of sect. *Sphagnum*, are often faint or absent; this was also reported by Eddy (1977) from other material. The species has not been found fertile in SE Asia (Eddy, 1977).

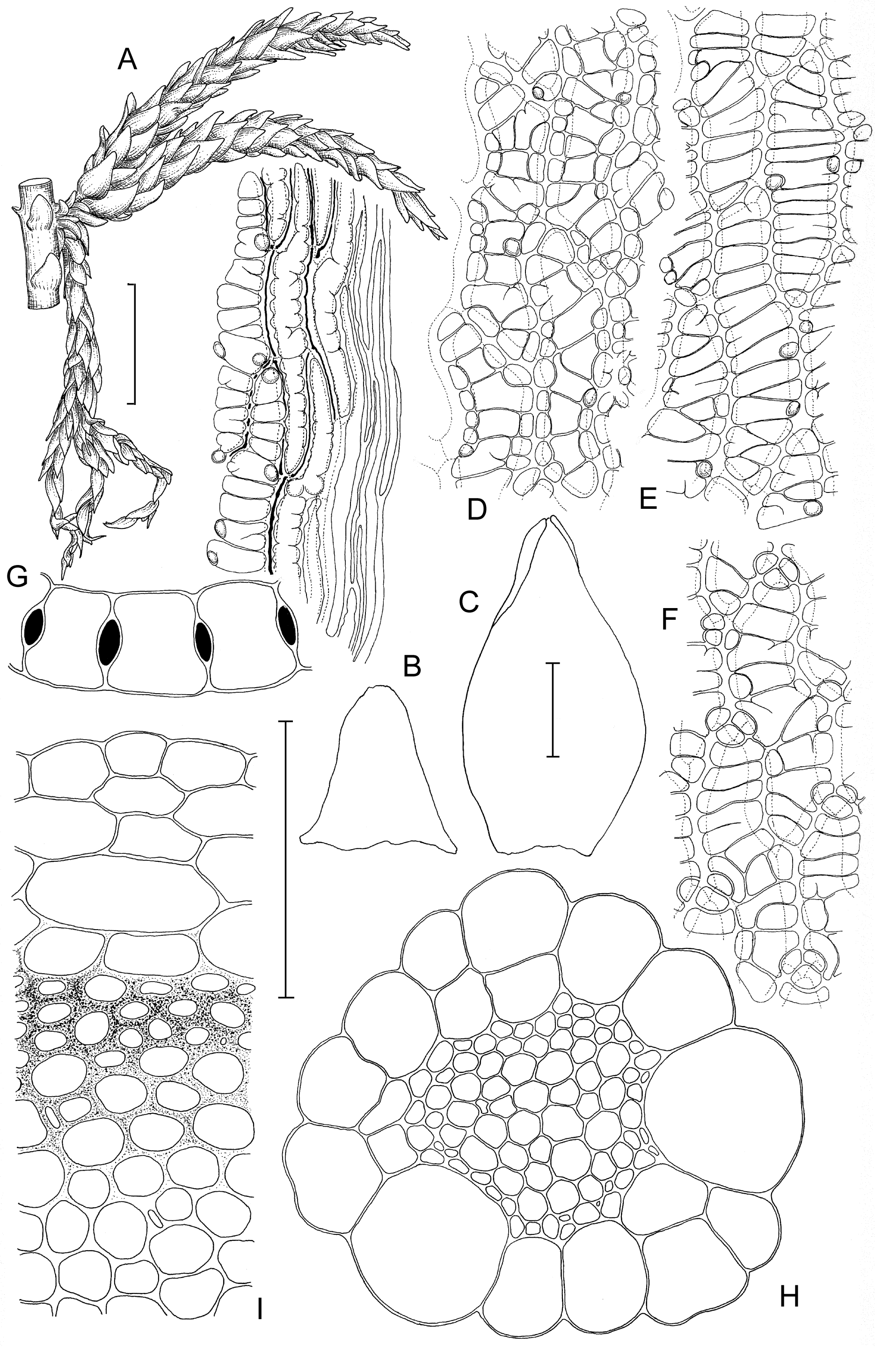
Sect. 2. Rigida

Sphagnum sect. **Rigida** (Lindb.) Schlieph. ex Limpr., *Rabenh. Krypt.-Fl.*, 2nd edn, 4(1): 116 (1885)

Type: *S. rigidum* (Nees & Hornsch.) Schimp.

Sphagnum vitjianum Schimp. ex Warnst., *Hedwigia* 30: 144, t. 14, fig. 8; t. 21, fig. 1 (1891). T: Viti Levu, Fiji, *Hooker 65*; holo: *n.v.*

Figure 4 (opposite). *Sphagnum australe*. **A**, Stem segment showing branch fascicle and stem leaves; **B**, Branch leaf; **C**, Stem leaf; **D**, Abaxial surface of upper mid-laminal cells of divergent branch leaf; **E**, **F**, Abaxial (E) and adaxial (F) surfaces of mid-laminal cells of divergent branch leaf; **G**, T.S. of divergent branch leaf; **H**, T.S. of branch; **I**, Part of T.S. of stem with 4–5 rows of cortical cells and the dense outer part of the scleroderm; **J**, Mid-lamina margin of divergent branch leaf (A–C, G, I, J, *J.Whinam s.n.*, HO; E, *P.G.Wilson 3566*, AD; H, *R.D.Seppelt 20263*, AAD). Scale bars: 5 mm for stem and branch fascicle; 1 mm for leaves; 100 µm for cells and sections. Drawn by R.D.Seppelt. Reproduced with permission from *Hikobia* 13: 171 (2000). © Hikobia Botanical Society.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Monoicous or dioicous. Stem cortical cells in 1–3 (–5) layers, without fibrils and pores, or cells in outer layer with 1 large pore. Branches always markedly dimorphic, with large incumbent or subsquarrose spreading branch leaves and reduced pale pendent branch leaves; pendent branches usually appressed to the stem; branch cortical cells without fibrils, uniform, the majority with a large pore near the distal end. Spreading branch leaves broad and ovate to elliptic, concave due to inrolled margins, often squarrose-truncate and dentate at the apex, rarely eroded but often somewhat cucullate, narrowly bordered, slightly denticulate by partial resorption of the marginal row of cells; adaxial surface pores usually in 3s and with pseudopores; abaxial surface pores with or without pseudopores, or absent; chlorophyllose cells narrow, almost to completely immersed on one or both leaf surfaces, with ovoid lumina. Stem leaves small and ±vestigial.

One species is known from Australia.

3. **Sphagnum australe** Mitt., *in* J.D.Hooker, *Fl. Tasman*. 2: 162 (1859)

Sphagnum compactum DC. var. *ovatum* Hook.f. & Wilson, *Fl. Antarct*. 1: 122 (1844); *S. antarcticum* Mitt. var. *australe* (Mitt.) Warnst., *nom. illeg.* T: Campbell Is., 1839–43, *J.D.Hooker* (*Wilson 5b*); lecto: BM-Wilson, *fide* A.J.Fife, *New Zealand J. Bot.* 34: 315 (1996).

Sphagnum confertum Mitt., *in* J.D.Hooker, *Fl. Tasman.* 2: 163 (1859). T: Cumming's Head, [Tas.], *W.Archer*; *n.v.*

Sphagnum antarcticum Mitt., *J. Proc. Linn. Soc., Bot.* 4: 100 (1860). T: Campbell Is., 1839–43, *J.D.Hooker* (*Wilson 5*); lecto: BM-Wilson, *fide* A.J.Fife, *New Zealand J. Bot.* 34: 315 (1996).

Sphagnum antarcticum Mitt. var. *fluctuans* Warnst., *Hedwigia* 29: 254 (1890). T: Campbell Is.[?], in Herb. Bescherelle, *fide* C.Warnstorf, *loc. cit.*

Sphagnum macrocephalum Warnst., *Hedwigia* 32: 7, t. 2, fig. 6 (1893); *S. antarcticum* Mitt. var. *macrocephalum* (Warnst.) Warnst., *Pflanzenreich* 51: 155 (1911). T: Lake Bellinger track, Zeehan, [Tas.], 7 Feb. 1891, *W.A.Weymouth 623, 624*; syn: H-BR, NSW.

Sphagnum antarcticum Mitt. var. *ericetorum* Müll.Hal. ex Warnst. f. *densissimum* Warnst., *Pflanzenreich* 51: 157 (1911); *S. antarcticum* Mitt. var. *densissimum* (Warnst.) Rodway, *Pap. & Proc. Roy. Soc. Tasmania* 1913: 254 (1914). T: Hartz Mtns, [Tas], *Mitchell 2325*; holo: H-BR.

Sphagnum campbellianum Müll.Hal., *Pflanzenreich* 51: 153 (1911), *nom. inval.* (in synon.).

Sphagnum falcirameum Müll.Hal., *Pflanzenreich* 51: 153 (1911), *nom. inval.* (in synon.).

Sphagnum orthocladum Bryhn ex Warnst., *Pflanzenreich* 51: 153 (1911), *nom. inval.* (in synon.).

Sphagnum antarcticum Mitt. var. *subsquarrosum* Warnst. ex Rodway, *Pap. & Proc. Roy. Soc. Tasmania* 1913: 255 (1914). T: not designated.

Sphagnum weymouthii Warnst. ex Rodway, *Pap. & Proc. Roy. Soc. Tasmania* 1913: 255 (1914). T: Mt Macmichael, Blue Tier, [Tas.]; holo: *n.v.*

Illustration: R.D.Seppelt, *Hikobia* 13: 171, fig. 3 (2000).

Possibly dioicous. Plants small to robust, whitish green to pale brownish green, sometimes weakly tinged brownish purple; capitulum usually ±obscured by upwardly directed branches. Stem cortical cells in 3–5 layers surrounding a pale brown internal cylinder; outermost layer efibrillose, most with 1 (–3) large distally placed pores. Branches in fascicles of 4 or 5, with 2 larger spreading and 2 or 3 slender pale pendent branches; branch cortical cells efibrillose, uniform in shape, in 2 or 3 layers surrounding a pale brown internal cylinder; with a single pore at the distal end. Branch leaves broadly ovate-lanceolate, acute to obtuse, concave, inrolled at margins, not roughened abaxially near apex, entire, with a few apical teeth, with a border of 2–4 rows of narrow cells and a weak intramarginal resorption furrow; adaxial surface pores fewer than on abaxial surface, often grouped in 2 or 3 in basal and adjacent lateral angles of cells; abaxial surface pores usually numerous (to 12–15), ±irregularly distributed along lateral commissures; chlorophyllose cells ovoid-elliptic in section, narrowly exposed on both surfaces. Stem leaves usually pendent, sometimes erect, lingulate, variably eroded, bordered. Fig. 4.

Occurs in N.S.W., A.C.T., Vic. and Tas., in lowland to subalpine, usually well-drained habitats. Also in South America, southern Africa and New Zealand. Map 3.

N.S.W.: Kew, *J.B.Cleland 21* (AD); Govetts Leap, Blackheath, *W.W.Watts 6134* (NSW). A.C.T.: Mt Franklin, *Hj.Eichler 13294* (AD). Vic.: Honeysuckle Ck, Victoria Ra., Grampians, *A.C.Beauglehole 4085* (MEL). Tas.: Ballroom Forest, Cradle Mtn, *D.G.Catcheside 86.108* (AD).

Sect. 3. Cuspidata

Sphagnum sect. **Cuspidata** (Lindb.) Schlieph. ex Schimp., *Syn. Musc. Eur.*, 2nd edn 829 (1876)

Type: *S. cuspidatum* Ehrh. ex Hoffm.

Monoicous or dioicous. Stem cortical cells in (1–) 2–3 (–4) layers, sometimes poorly differentiated from internal cylinder, without pores or fibrils. Branches uniform or dimorphic; branch cortical cells dimorphic, with distinct retort cells bearing a single ±apical pore, not fibrillose. Branch leaves ovate to lanceolate, sometimes very long and narrow, strongly bordered and with involute margins, never with resorption furrows; apices narrowly truncate-dentate; adaxial surface pores lacking, or few near cell angles; abaxial surface pores lacking or few, small to medium-sized; chlorophyllose cells triangular to trapezoidal in section, always with wider exposure on abaxial surface and commonly immersed below adaxial surface of leaf. Stem leaves variable in size and shape.

One species occurs in Australia.

4. **Sphagnum falcatulum** Besch., *Bull. Soc. Bot. France* 32: LXVII (1885)

T: Île Hoste, Cape Horn, 1883, *Hyades*; holo: *n.v.*

Sphagnum serrulatum Warnst., *Hedwigia* 32: 1 (1893). T: Zeehan Railway, Zeehan, Tas., 9 Feb. 1891, *W.A.Weymouth 622*; holo: H-BR; iso: NSW.

Sphagnum lancifolium Müll.Hal. & Warnst., *Hedwigia* 36: 154 (1897). T: Sydney, [N.S.W.], Nov. 1893, *T.Whitelegge*; holo: B, presumably destroyed.

Sphagnum wattsii Warnst., *Bot. Centralbl.* 76: 421 (1898). T: Richmond R., [N.S.W.], Sept. 1898, *W.W.Watts 1113*, *1024*; syn: H-BR.

Sphagnum serratifolium Warnst., *Bot. Centralbl.* 82: 72 (1900). T: Tyagarah Rd, Byron Bay, N.S.W., Aug. 1899, *W.W.Watts 3086*; holo: H-BR.

Sphagnum brotherusii Warnst., *Bot. Centralbl.* 82: 74 (1900). T: Tyagarah Rd, Byron Bay, N.S.W., *W.W.Watts 3075*, *3085*; syn: H-BR; E of Ballina, N.S.W., Sept. 1898, *W.W.Watts 2273*; syn: H-BR.

Sphagnum drepanocladum Warnst., *Bot. Centralbl.* 82: 75 (1900). T: Whaws Bay, Ballina, N.S.W., Apr. 1899, *W.W.Watts 2851*; holo: H-BR; iso: NSW.

Sphagnum trichophyllum Warnst., *Hedwigia* 39: 100 (1900). T: Mt Wellington [Tas.], 25 Dec. 1887, *R.A.Bastow 2213*; H-BR.

Sphagnum serratum Austin var. *serrulatum* (Schlieph.) Warnst., *Pflanzenreich* 51: 247 (1911), *nom. illeg.* (later homonym).

Sphagnum brotherusii Warnst. var. *plumosulum* Warnst., *Pflanzenreich* 51: 248 (1911). T: *s. loc.*, N.S.W., *W.W.Watts 4265*; syn?: NSW.

Sphagnum wattsii Warnst. var. *leptocladum* Warnst., *Pflanzenreich* 51: 272 (1911). T: Richmond River, N.S.W., *W.W.Watts 5606*; syn?: NSW.

Sphagnum wattsii Warnst. var. *macrophyllum* Warnst., *Pflanzenreich* 51: 272 (1911). T: Newcastle, N.S.W., *Murson 4521* ex Herb. Watts; syn?: NSW.

Sphagnum rodwayi Warnst., *in* L.Rodway, *Pap. & Proc. Roy. Soc. Tasmania* 1913: 257 (1914). T: Strickland, Tas.; syn: HO, NSW.

Illustrations: R.D.Seppelt, *Hikobia* 13: 172, fig. 4 (2000); R.D.Seppelt, *The Moss Flora of Macquarie Island* 263, fig. 102; 271, fig. 109 (2004).

Monoicous. Plants delicate to robust, pale yellowish green to light green, finely branched; capitulum well defined. Stem cortical cells in 1 or 2 layers, sometimes indistinct, elongate, lacking pores or fibrils; internal cylinder greenish to yellowish. Branches in fascicles of 3 or 4, 1 or 2 spreading branches, 1 or 2 pendent branches ±similar to well differentiated; branch

cortical cells in 1 layer, the retort cells clearly differentiated and with a weakly protruding distal pore, elongate. Branch leaves ovate-lanceolate; apex narrow, toothed across the apex; margin ±undulate, inrolled towards the apex; with a border of 2 or 3 rows of narrow elongate cells; hyaline cells elongate; adaxial surface pores/pseudopores few, 1–8 or occasionally more, terminal or lateral at junction of cells; abaxial surface pores 2–8, unringed, along the lateral commissures, mostly at junctions of cells; chlorophyllose cells trapezoidal in section, exposed more widely on abaxial surface; commissural walls smooth. Stem leaves erect, spreading or pendent, broadly triangular to ±lingulate, bordered; hyaline cells fibrillose in upper part, efibrillose in the lower half, with 4–8 adaxial pores per cell in upper fibrillose cells. Fig. 5.

Occurs in N.S.W., Vic. and Tas.; usually in wet habitats from near sea level to subalpine, often in water where the plants can assume a particularly feathery appearance. Also in Macquarie Is., New Zealand and South America. Map 4.

N.S.W.: Mt Budawang, *E.F.Constable 6967* (NSW). Vic.: Mt Clay State Forest, *A.C.Beauglehole 4471* (MEL); La Trobe R., Powelltown, Oct. 1929, *J.H.Willis* (MEL). Tas.: Blue Tier, *W.A.Weymouth 2397* (HO).

Scott & Stone (*The Mosses of Southern Australia* 60, 1976) reported this species from Queensland, but I have not seen any specimens from that State.

Rodway (1914) incorrectly attributed the name *Sphagnum cuspidatum* Ehrh. ex Hoffm., to specimens from Macquarie Harbour and Mt Wellington in Tasmania, and this misidentification has been perpetuated in the literature (Scott & Stone, 1976; Streimann & Curnow, 1989; Dalton *et al.*, 1991). Rodway's description is confused as it appears to be based on two distinct taxa, *S. falcatulum* and *S. novozelandicum*. The chlorocysts being in section "obtusely wedge shaped, the convex base free on the external surface" is characteristic of the former species while the hyalocysts having pores "small, circular, … many along both margins" suggests the latter. Willis (1953) correctly referred *S. cuspidatum sensu* Warnstorf (1911) to *S. falcatulum*. *Sphagnum cuspidatum* is primarily a Northern Hemisphere species.

Sect. 4. Subsecunda

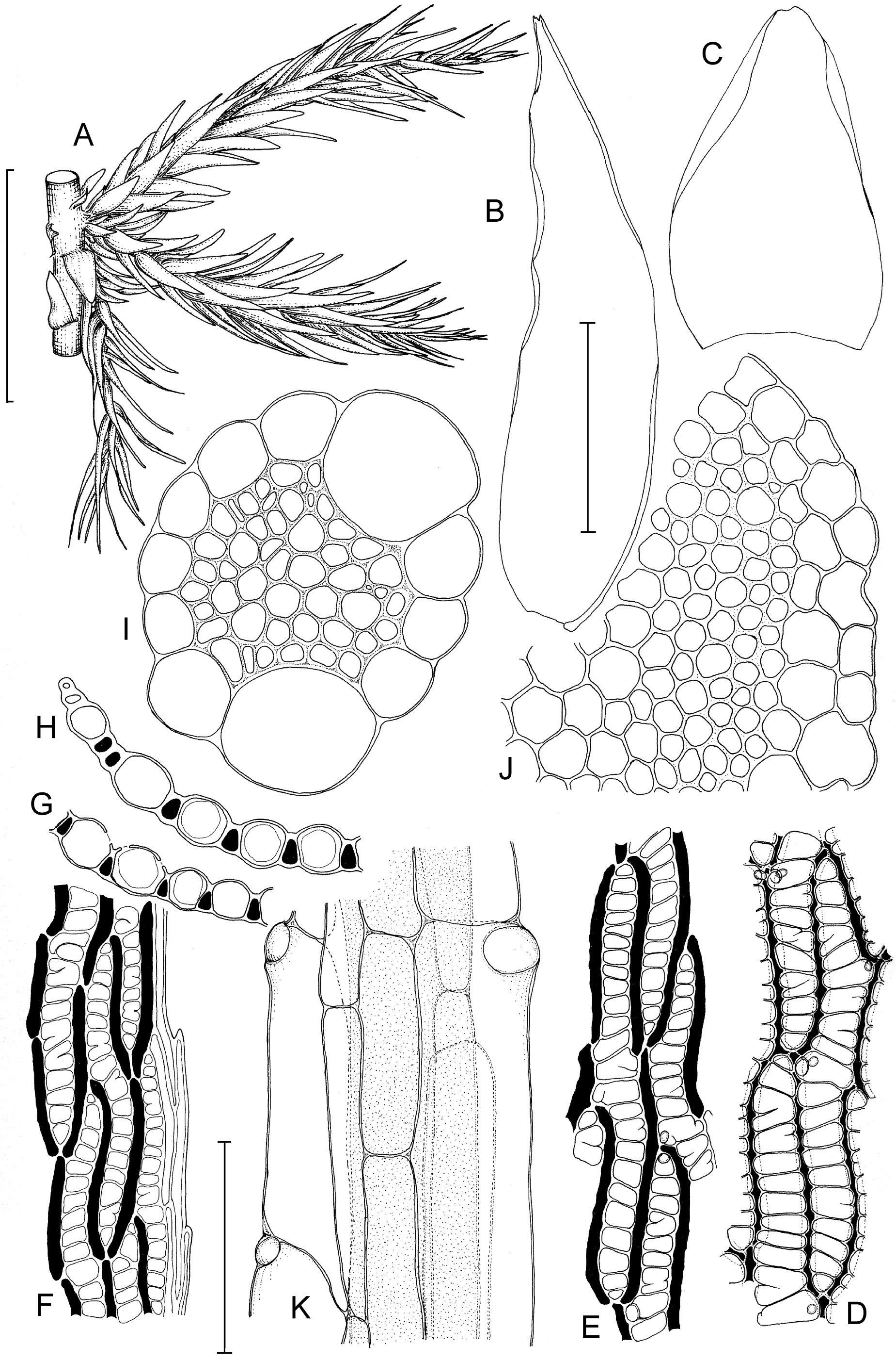
Sphagnum sect. **Subsecunda** (Lindb.) Schlieph. ex Schimp., *Syn. Musc. Eur.*, 2nd edn 1843 (1876)

Type: *S. subsecundum* Nees

Dioicous. Stem cortical cells usually in 1 or 2 (–4) layers, thin-walled, without fibrils, without pores or occasionally porose on the outer surface. Branches not or weakly dimorphic; branch cortical cells similar to stem cortical cells. Branch leaves proportionately broad, ovate-lanceolate to broadly ovate or elliptic, concave, narrowly truncate and dentate or eroded across apices, narrowly bordered by linear cells; hyaline cells typically long and narrow; adaxial surface pores numerous, very small, ringed, on one or both sides of the cells; abaxial surface pores absent or few to numerous; chlorophyllose cells in section normally thick-walled and barrel-shaped, ovate or urceolate with oval lumina. Stem leaves variable, sometimes greatly reduced, commonly as large as or larger than branch leaves, resembling branch leaves in cell form and structure.

Two species occur in Australia.

Figure 5 (opposite). *Sphagnum falcatulum*. **A**, Stem segment showing branch fascicle and stem leaves; **B**, Branch leaf; **C**, Stem leaf; **D**, **E**, Adaxial (D) and abaxial (E) surfaces of mid-laminal cells of branch leaf; **F**, Leaf marginal cells in mid-lamina; **G**, **H**, T.S. of branch leaves; **I**, T.S. of branch; **J**, Part of T.S. of stem with 1–2 rows of cortical cells and the dense, outer part of the scleroderm; **K**, Branch, lateral view showing retort cells (A, F, H–J, *R.D.Seppelt 14657*, AAD; B–E, G, K, *R.D.Seppelt 3553*, AAD). Scale bars: 5 mm for stem and branch fascicle; 1 mm for leaves; 100 µm for cells and sections. Drawn by R.D.Seppelt. Reproduced with permission from *Hikobia* 13: 172 (2000). © Hikobia Botanical Society.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5. Sphagnum fuscovinosum Seppelt & H.A.Crum, *Contr. Univ. Michigan Herb.* 22: 132 (1999)

T: Tarn Shelf, Mount Field Natl Park, Tas., *P.J.Dalton 91.2*; holo: HO; iso: Herb. Dalton, CHR, MICH.

Illustration: R.D.Seppelt & H.A.Crum, *loc. cit.*, fig. 1.

Plants burgundy to deep purple-brown, branching by irregular dichotomies, lacking fascicles, to 12 cm long. Stem cortical cells in a single layer surrounding a pale yellow to brown internal cylinder, lacking fibrils, mostly without pores; retort cells not differentiated. Leaves broadly ovate, with a truncate and irregularly 3–5-toothed apex, to 6 mm long, strongly concave, bordered by 4–6 rows of narrow elongate cells. Hyalocysts narrowly elongate, 150–200 × 15–20 µm in upper median leaf, fibrillose, becoming slightly longer below; abaxial surface pores 12–20 along margins, 4–6 µm diam., rounded to ellipsoidal; adaxial surface pores 3 or 4 per cell, similar in size and position; chlorophyllose cells in section barrel-shaped, broadly exposed on both surfaces. Reproductive structures not seen. Fig. 6.

Endemic to Tas.; found in shallow, alpine moorland pools over basic Jurassic doleritic substrata above 1000 m. Map 5.

Tas.: Mt Mawson Plateau, Mount Field Natl Park, *A.V.Ratkowsky H 447* (HO); *loc. id.*, *P.J.Dalton 82.124* (HO); Newdegate Pass, Mount Field Natl Park, *Dobson 77021* (CHR); Ben Lomond Natl Park, 13 Jan. 1979, *A.Moscal* (HO).

Considering the robustness of the plants, the stems are remarkably slender. It is likely that the species will be located in other alpine areas, at least over doleritic rather than quartzite or granitic rock, but detailed surveys have not been undertaken in many areas.

Like *S. simplex* Fife in New Zealand (Fife, 1996), collections of *S. fuscovinosum* have come from waterlogged habitats in shallow pools in subalpine to alpine locations. Plants of *S. simplex* are a pale chestnut to pale brownish green, compared to the deep purple-brown of *S. fuscovinosum*, the diameter of the branches (stem and leaves) is narrower, the leaves are smaller, and the abaxial pores of the hyalocysts are larger.

6. Sphagnum novozelandicum Mitt., *J. Proc. Linn. Soc., Bot.* 4: 99 (1860)

T: New Zealand, *Kerr*; lecto: NY *n.v.*, *fide* A.J.Fife, *New Zealand J. Bot.* 34: 321 (1996).

Sphagnum cymbifolioides Müll.Hal., *Bot. Zeitung* (*Berlin*) 9: 546 (1851), *nom. illeg.* (later homonym).

Sphagnum contortum Schultz var. *intermedium* Wilson, *in* J.D.Hooker, *Fl. Tasman.* 2: 162 (1859). T: *s. loc.*, [Tas.], *A.F.Oldfield 29*; holo: BM? *n.v.*

Sphagnum contortum Schultz var. *laxum* Wilson, *in* J.D.Hooker, *Fl. Tasman.* 2: 162 (1859). T: Mt Wellington, [Tas.], *R.C.Gunn 41*; holo: BM? *n.v.*

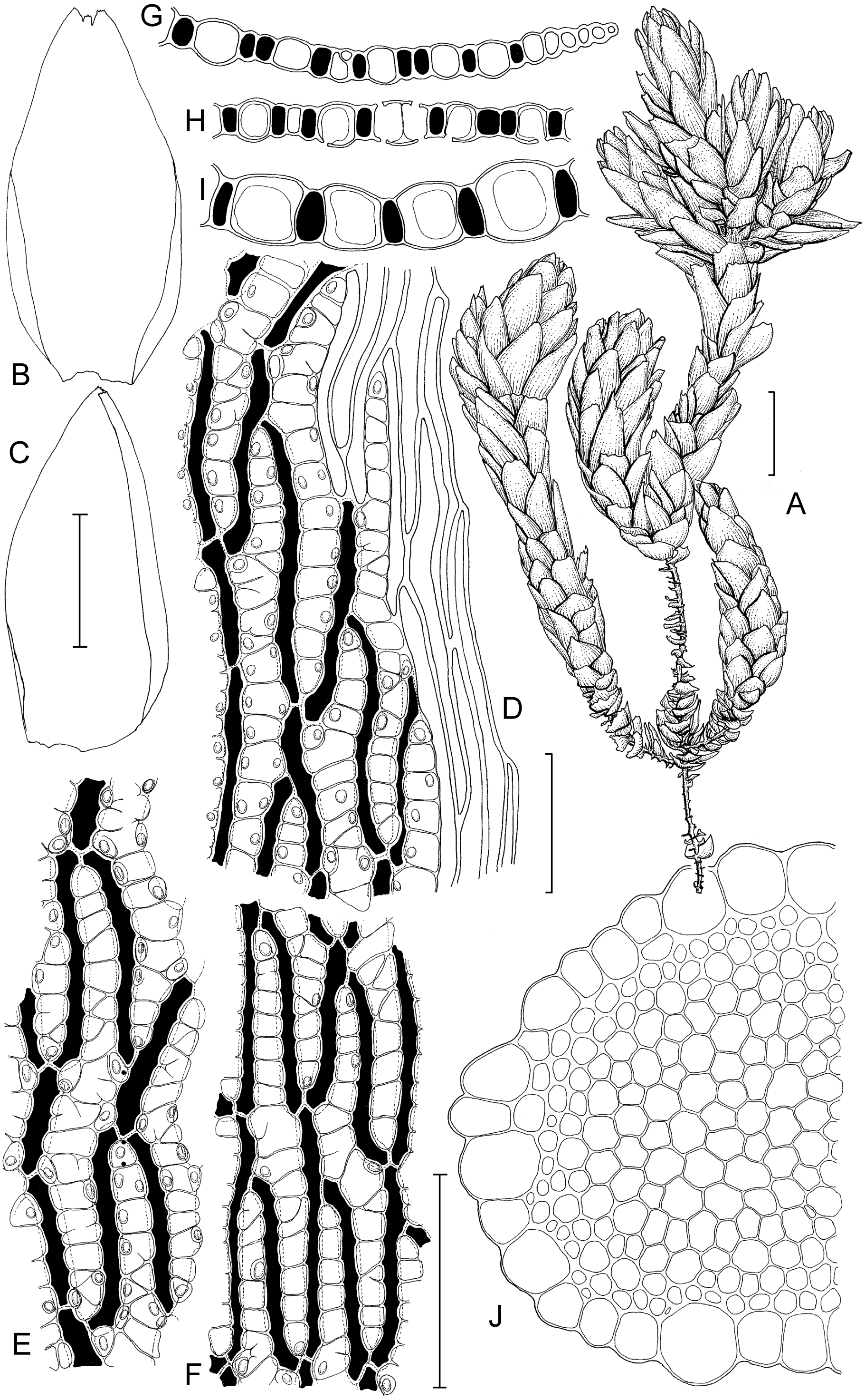
Sphagnum contortum Schultz var. *scorpioides* Wilson, *in* J.D.Hooker, *Fl. Tasman.* 2: 162 (1859). T: Mt Wellington, [Tas.], *R.C.Gunn 2*; holo: BM? *n.v.*

Sphagnum molliculum Mitt., *in* J.D.Hooker, *Fl. Tasman.* 2: 163 (1859). T: Cheshunt, [Tas.], *W.Archer*; holo: NY

Sphagnum subcontortum Hampe, *Linnaea* 40: 301 (1876); *S. subsecundum* Nees var. *subcontortum* (Hampe) A.Jaeger, *Ber. Tätigk. St. Gallischen Naturwiss. Ges.* 1877–78: 364 (1879) (Ad. 2: 628). T: Mt Warning, [N.S.W.], *W.Guilfoyle*; holo: B, presumably destroyed; iso: NSW.

Sphagnum comosum Müll.Hal., *Flora* 70: 413 (1887). T: Waterloo Marshes, Sydney, [N.S.W.], Nov. 1883, *T.Whitelegge*; syn: NSW; Berwick, [Vic.], *G.W.Robinson*; syn: MEL.

Figure 6 (opposite). *Sphagnum fuscovinosum*. **A**, Single branched plant; note the absence of branch fascicles; **B**, **C**, Leaves; **D**, Leaf marginal cells in mid-lamina, abaxial surface; **E**, **F**, Abaxial (E) and adaxial (F) surfaces of leaf mid-laminal cells; **G–I**, T.S. of leaves; **J**, Part of T.S. of stem (A–J, *P.J.Dalton 91.2*, HO). Scale bars: 5 mm for plant; 2 mm for leaves; 100 µm for mid-laminal cells and stem section; 50 µm for marginal cells and leaf sections. Drawn by R.D.Seppelt. Reproduced with permission from *Contr. Univ. Michigan Herb.* 22: 132 1999). © University of Michigan.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Sphagnum mossmannianum Müll.Hal., *Hedwigia* 29: 184 (1891), *nom. inval.* (in synon.).

Sphagnum dubiosum Warnst., *Hedwigia* 30: 20 (1891). T: "Süd-Australien", *F.M.Campbell 5*; holo: H-BR.

Sphagnum pseudorufescens Warnst., *Hedwigia* 32: 6 (1893). T: Mt Wellington, Tas., 15 Feb. 1888, *W.A.Weymouth 972*; syn?: BM, CHR, HO, NSW.

Sphagnum moorei Warnst., *Allgem. Bot. Zeitschr*. 1: 204 (1895). T: Kellys Basin and Macquarie Harbour [Tas.], *Moore 54*, in Herb. W.A.Weymouth *1602*; iso: HO.

Sphagnum submolliculum Warnst., *Hedwigia* 36: 164 (1897). T: Kellys Basin, [Tas.], *J.B.Moore*; holo: H-BR.

Sphagnum sullivanii Müll.Hal., *Genera Musc. Frond.* 103 (1900). T: Mt William Creek, Grampians, [Vic.], Aug. 1875, *D.Sullivan 18*; holo: B, presumably destroyed.

Sphagnum commutatum Warnst., *Magyar Bot. Lapok.* 1: 45 (1902). T: Three Mile Scrub, Byron Bay, N.S.W., 2 May 1900, *W.W.Watts 4209*; holo: NSW.

Sphagnum laticoma Müll.Hal. ex Warnst., *Pflanzenreich* 51: 312 (1911). T: Black Spur, [Vic.], *coll. unknown*; holo?: MEL *n.v.*

Sphagnum moorei Warnst. var. *macrophyllum* Warnst., *Pflanzenreich* 51: 369 (1911). T: Port Esperance, [Tas.], *W.A.Weymouth 1693*; iso: HO.

Sphagnum novozelandicum Mitt. var. *commutatum* Warnst., *Pflanzenreich* 51: 334 (1911). T: *s. loc.*, [N.S.W.], *W.W.Watts 3735*, *3759*, *3775*, *4200*, *4210*, *4453*; syn: H-BR; isosyn (of *3759*, *3775*, *4453*): NSW.

Sphagnum novozelandicum Mitt. var. *laxifolium* Warnst., *Pflanzenreich* 51: 334 (1911). T: *s. loc.*, [N.S.W.], *W.W.Watts 3734*, *5190*, *5191*, *5192*; syn: H-BR; isosyn (of *5191*): NSW.

Sphagnum novozelandicum Mitt. var. *molle* Warnst., *Pflanzenreich* 51: 332 (1911). T: Maroubra Bay, [N.S.W.], *T.Whitelegge 435*; holo: H-BR; iso: NSW.

Sphagnum novozelandicum Mitt. var. *pauciporosum* Warnst., *Pflanzenreich* 51: 334 (1911). T: *s. loc.*, [N.S.W.], *W.W.Watts 4272*; iso: NSW.

Sphagnum novozelandicum Mitt. var. *pulvinatum* Warnst., *Pflanzenreich* 51: 334 (1911). T: Mt Wellington, [Tas.], *F.L.E.Diels 6186*; holo: B, presumably destroyed.

Sphagnum pseudorufescens Warnst. var. *flavescens* Warnst., *Pflanzenreich* 51: 371 (1911). T: *s. loc.*, [N.S.W.], *W.W.Watts 200*; iso: NSW.

Sphagnum pseudorufescens Warnst. var. *fuscorufescens* Warnst., *Pflanzenreich* 51: 371 (1911). T: *s. loc.*, [Tas.], *W.A.Weymouth 972*, *973*, *975*, *976*, *977*; syn: HO.

Sphagnum pseudorufescens Warnst. var. *fuscorufescens* Warnst. f. *dicladum* Warnst., *Pflanzenreich* 51: 371 (1911). T: *s. loc.*, [N.S.W.], *W.W.Watts 6183*; iso: NSW.

Sphagnum pseudorufescens Warnst. var. *pallens* Warnst., *Pflanzenreich* 51: 371 (1911). T: *s. loc.*, [Tas.], *W.A.Weymouth 2133*; iso?: HO.

Sphagnum pseudorufescens Warnst. var. *virescens* Warnst., *Pflanzenreich* 51: 371 (1911). T: *s. loc.*, [N.S.W.], *W.W.Watts 6194*; iso: HO.

Illustrations: R.D.Seppelt, *Hikobia* 13: 176, fig. 6; 177, fig. 7 (2000).

Dioicous. Plants very variable, small and cushion-forming to robust, yellowish brown, sometimes tinged with brownish purple; capitulum well defined with curved branches in cushion forms to ill-defined in aquatic forms. Stem cortical cells in 1 (–2) layers, surrounding a pale brownish central cylinder; outer cortical cells usually with a single distal pore, sometimes eporose. Branches in fascicles of 3–5, with 2 or 3 divergent branches and 1 or 2 more slender pendent branches; spreading branches often curved; aquatic forms with 1 or 2 branches in fascicles; branch cortical cells in a single layer, dimorphic; retort cells larger in section, with a single projecting pore at distal end. Branch leaves ovate to ovate-lanceolate, erect-spreading or appressed, strongly concave, with 3 or 4 apical teeth due to resorption; border of 1–3 rows of narrow cells; adaxial surface pores lacking or very sparse; abaxial surface pores small, ringed, numerous, 8–16 along commissures; chlorophyllose cells broadly oblong or truncated-elliptic, equally exposed on both surfaces; commissural walls smooth. Stem leaves mostly pendent, lingulate, rounded or obtuse, ±eroded near apex, bordered by 3–5 rows of narrow cells, fibrillose throughout, more weakly so in lower half of leaf; abaxial surface of hyaline cells with numerous strongly ringed pores in rows along commissures; adaxial surface with no or few pores.

Occurs in W.A., N.S.W., A.C.T., Vic. and Tas., from near sea level to subalpine; grows in moist to wet habitats in woodland, acidic shrubland or grassland and in roadside ditches. Also in New Zealand and Campbell Is. Map 6.

W.A.: Weld River Bridge, SE of Manjimup, Aug. 1966, *G.G.Smith* (PERTH). N.S.W.: Jigamy Ck, Eden, *E.F.Constable* (NSW). A.C.T.: Little Ginini, Brindabella Ra., *H.Streimann 4169* (CANB). Vic.: between Zumsteins and McKenzie Falls, Grampians Natl Park, *A.C.Beauglehole 74107* (MEL). Tas.: Western Tiers, Dec. 1908, *L.Rodway* (HO).

The record from Western Australia, as *S. subsecundum*, was discussed in detail by Smith (1969).

I have included in *S. novozelandicum* Australian material misidentified as *S. molliculum*, *S. subsecundum* and *S. cymbifolioides*, as well as numerous Watts and Warnstorf names. I have taken this approach for simplicity, while at the same time acknowledging that the *Subsecunda* group is in need of further critical evaluation.

Doubtful and Excluded Names

Sphagnum centrale C.E.O.Jensen, *Bih. Kongl. Svenska Vetensk.-Akad. Handl.* 21, Afd. 3(10): 34 (1896)

This is a circumpolar, Northern Hemisphere species with continental tendencies (P.Isoviita, Studies on *Sphagnum*. I. Nomenclatural revision of the European taxa, *Ann. Bot. Fenn.* 3: 199–264, 1966). It is sometimes confused with *S. magellanicum*, but the two differ in morphology, ecology and distribution. Warnstorf (*Kryptogamenfl. Mark Brandenburg* 1: xv, 1–481, 1902–03, 1911) regarded Australasian material he had earlier determined as *S. whiteleggei* to be referable to *S. centrale*. *Sphagnum whiteleggei* was subsequently synonymised under *S. cristatum* by Willis (1953). The record of *S. centrale* for Australia is, therefore, erroneous.

Sphagnum compactum DC., *Fl. Franç.* 443 (1805)

Although listed for Australia by Streimann & Curnow (1989), Fife (1996) observed that the original record from Tasmania (J.D.Hooker, *Fl. Tasman.* 2: 162, 1859) is referable to *S. australe*. The distance along the stems between fascicles of branches is very variable, and some forms with very short internodes have the appearance of *S. compactum*. In Australia such forms, based on an examination of herbarium specimens, appear to be rare, and all the material I have examined is *S. australe*. Fife (1996) discussed the features that distinguish the two species.

Sphagnum dominii Kavina, *Sitzungsber. Königl. Bohm. Ges. Wiss. Prag. Math.-Naturwiss. Cl.* 1915(9): 2 (1916)

Listed by Streimann & Curnow (1989), but I have not been able to trace the origin of this record in the original publication, and it must remain doubtful.

Sphagnum magellanicum Brid., *Muscol. Recent.* 2(1): 24 (1798)

I have not seen any Australian material referable to this species. It was reported in an unpublished list of mosses from the A.C.T. by W.A.Weber in 1968 (*fide* Streimann & Curnow, 1989). The outer cortex of the stem either lacks or has only faintly developed fibrils. Typical plants are usually reddish pink. The plants are also rather robust, and it is likely that Australian records are misidentifications of *S. cristatum* or *S. australe*.

Sphagnum naumanii Müll.Hal., *Bot. Jahrb. Syst.* 5: 87 (1883)

Referred by Willis (1953) to probable synonymy under *S. falcatulum*. The type is from Qld and has not been located.

Sphagnum palustre L., *Sp. Pl.* 1106 (1753)

This is a Northern Hemisphere species (sect. *Sphagnum*) having similar leaf shape, stem sectional anatomy and fibrillar thickenings in the stem outer cortical cells to those of

S. cristatum. However, in *S. palustre* the chlorocysts in sections of the branch leaves are exposed on the abaxial surface. Australian reports probably belong to *S. cristatum* Hampe, although the morphological similarities of these species merit further investigation.

Sphagnum scortechinii Müll.Hal., *Hedwigia* 36: 153 (1897)

Referred by Willis (1953) to probable synonymy under *S. falcatulum*. The type is from Qld, without locality or date, collected by Scortechini, and originally placed in B. The specimen has not been located and is likely to have been destroyed in 1943. The description in Warnstorf (1911) indicates at least a close similarity to *S. falcatulum*.

Sphagnum subsecundum Nees var. *rufescens* (Nees & Hornsch.) Huebener, *Musc. Germ*. 26 (1833)

There is one published Australian record of this variety, from N.S.W. (Crum 1984, p. 63). However, this taxon was considered by Crum (pers. comm.) not to be represented in the Australian flora.

Sphagnum vitianum Schimp. ex Warnst., *Hedwigia* 30: 144 (1891)

Reported from Australia by Kavina (Ein Beitrag zur Torfmoosflora Australiens, *Sitzungsber. Konigl. Bohm. Ges. Wiss. Prag., Math.-Naturwiss*. 1915(9): 1–9, 1916) and listed without verification by Streimann & Curnow (1989). Warnstorf (1911) recorded the species only from Fiji, while Andrews (Studies in the Warnstorf *Sphagnum* herbarium. VI. The subgenus *Inophloea* in the eastern hemisphere, *Bryologist* 54: 83–91, 1951) referred *S. vitianum* to *S. palustre* L. The report for Australia appears to be erroneous, and the specimens reported by Kavina are considered here to be most likely referable to *S. cristatum*.

AMBUCHANANIACEAE

Rodney D. Seppelt[1]

Ambuchananiaceae Seppelt & H.A.Crum, *in* H.A.Crum & R.D.Seppelt, *Contr. Univ. Michigan Herb.* 22: 29 (1999), *nom. inval.*; *Fl. Australia* 51: 406 (2006).

Type: *Ambuchanania* Seppelt & H.A.Crum

Autoicous. Stem cortical cells in a single layer, weakly differentiated from underlying cells, without pores or fibrils; scleroderm lacking. Stem leaves large, imbricate, bordered by 15–20 rows of narrow cells with pitted walls in mid-lamina. Branches erect, dimorphic, short and long, not forming fascicles; branch cortical cells similar to those of the stem. Branch leaves narrower than stem leaves; hyaline cells with rudimentary fibrils on abaxial lower surface; adaxial surface pores simple, solitary, in centre of cell surface on branch leaves, absent on stem leaves; abaxial surface pores simple, forming a pore-like structure at junction of 4 hyaline cells, with ringed pores on walls between 2 hyaline cells, scattered, up to 10 per cell on stem leaves. Chlorophyllose cells of leaves located on adaxial side of hyaline cells (in cross-section). Perichaetia terminal; perigonia lateral, borne immediately below perichaetia; antheridia oblong-ellipsoidal.

A monotypic family, the only species being endemic to Tasmania.

This family differs from Sphagnaceae in the location of the chlorophyllous cells in cross-sections of the leaves, the ringed thickenings found in leaf hyaline cells, and in the elongate antheridia.

H.A.Crum & R.D.Seppelt, *Sphagnum leucobryoides* reconsidered, *Contr. Univ. Michigan Herb*. 22: 29–31 (1999); R.D.Seppelt & H.[A.]Crum, *Sphagnum fuscovinosum*, a new species from Australia, *Contr. Univ. Michigan Herb.* 22: 131–134 (1999); R.D.Seppelt, The Sphagnopsida (Sphagnaceae; Ambuchaniaceae) in Australia, *Hikobia* 13: 163–183 (2000).

AMBUCHANANIA

Ambuchanania Seppelt & H.A.Crum, *in* H.A.Crum & R.D.Seppelt, *Contr. Univ. Michigan Herb.* 22: 29 (1999); named in honour of Alex M. Buchanan, the original collector.

Type: *A. leucobryoides* (T.Yamag., Seppelt & Z.Iwats.) Seppelt & H.A.Crum.

Sphagnum sect. *Buchanania* T.Yamag., Seppelt & Z.Iwats., *Hikobia* 11: 139 (1992), *nom. illeg.*, *non* Yamaguchi *et al.*, *J. Bryol.* 16: 45 (1990).

Description as for the family.

Ambuchanania leucobryoides (T.Yamag., Seppelt & Z.Iwats.) Seppelt & H.A.Crum, *in* H.A.Crum & R.D.Seppelt , *Contr. Univ. Michigan Herb*. 22: 29 (1999)

Sphagnum leucobryoides T.Yamag., Seppelt & Z.Iwats., *J. Bryol.* 16: 45 (1990). T: Port Davey, Coffin Bay, Tas., *A.M.Buchanan 9371*; holo: HO.

Illustrations: T.Yamaguchi, R.D.Seppelt & Z.Iwatsuki, *op. cit.* 45–54, figs 1–6, as *Sphagnum leudobryoides*; R.D.Seppelt, *Hikobia* 13: 180, fig. 8 (2000).

Plants small, pale brown or whitish green (when dry), somewhat glossy. Stems c. 2 cm long, irregularly and sparsely branched. Stem leaves suberect to widely spreading, broadly lanceolate, 3.6–4.3 mm long, 1.5–1.7 mm wide, concave, tubular in upper part; apex rounded-obtuse or narrowly truncate; margin entire or irregularly sparsely toothed at the base; hyaline

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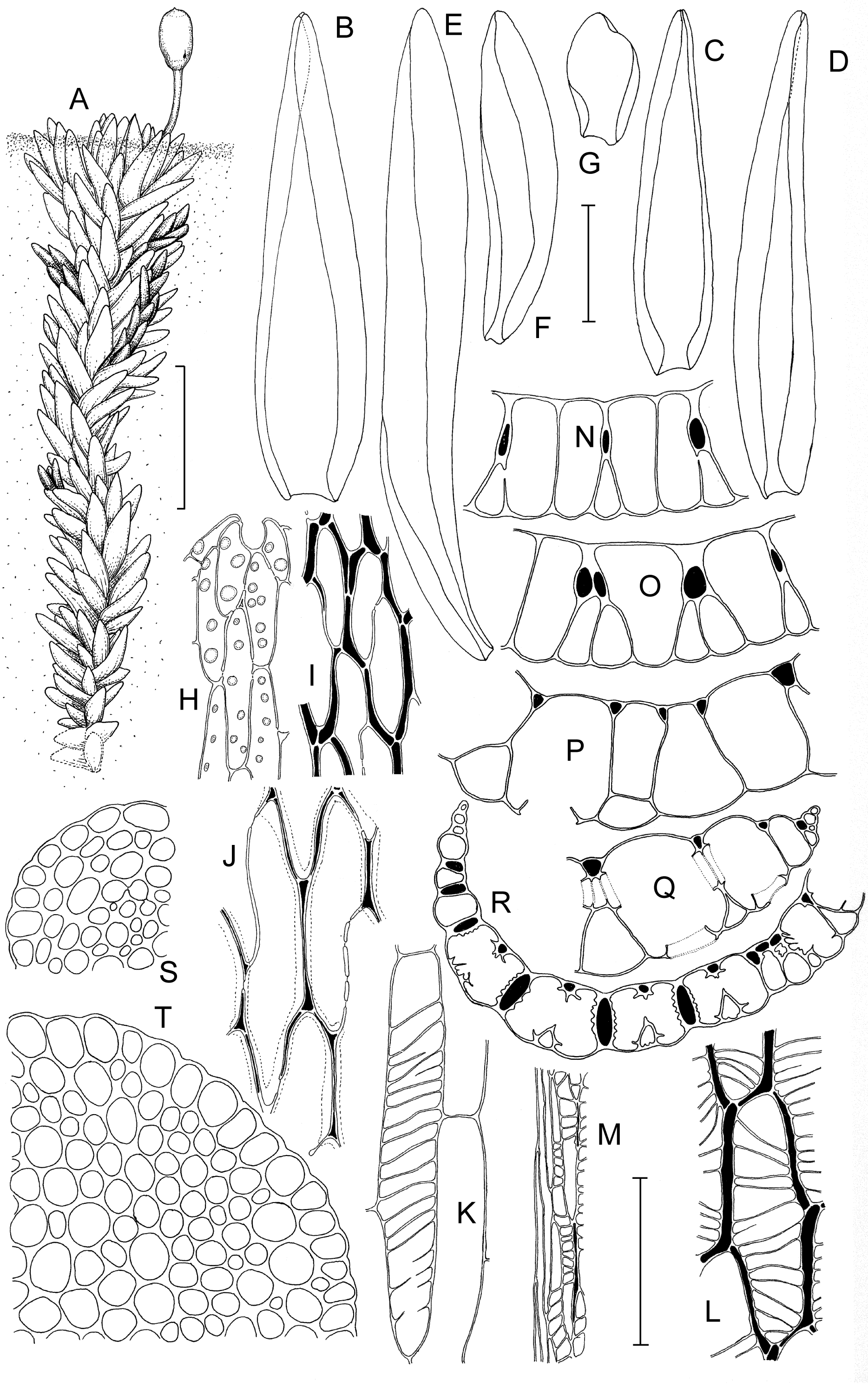
cells of stem leaves narrowly rectangular or narrowly rhomboidal on abaxial surface, broadly rhomboidal on adaxial surface; fibrils rudimentary; unringed pores scattered on abaxial surface at apical part of leaf; chlorophyllose cells of stem leaves with lumina oblong to oval (cross-section). Long branches 3–5 mm long; branch leaves lanceolate, with cells similar to stem leaves. Short branches few, single or paired, c. 0.3 mm long, with 8–10 appressed imbricate leaves; upper leaves narrowly obovate, to 8.6 mm long and 1.1 mm wide; hyaline cells of upper leaves slightly inflated on both sides (cross-section), fibrillose except for cells at apical and basal parts of leaf. Chlorophyllose cells of stem leaves with oblong to oval lumina, usually immersed on both surfaces of leaf (cross-section); those of branch leaves dimorphic, exposed adaxially, with small rounded-triangular to oval lumina, or with narrowly elliptic lumina, thick-walled and with papillae on internal commissural walls of hyaline cells. Lower leaves of short branches obovate, concave, with a border of 10–15 rows of cells in mid-leaf. Perichaetial leaves ovate, concave, 3.3–3.4 mm long, 1.4–1.6 mm wide; apex rounded. Antheridia c. 0.50 × 0.15 mm, in a fascicle of 2–4; antheridial stalks 0.3–0.4 mm long, connected at base; perigonial leaves similar to perichaetial leaves. Pseudopodium c. 3.5 mm long. Capsules 1.0–1.1 mm diam., with many pseudostomata in lower half. Fig. 7.

Endemic to Tas.; collected from white quartzitic sand deposited by alluvial flow; also at the margin of a *Gymnoschoenus* sedgeland. Map 7.

Tas.: Jane R., SW of Butlers Gorge, Central Plateau, *S.J.Jarman* (HO 34540).

This is readily distinguished from *Sphagnum* species by the following characteristics: plants having a *Leucobryum*-like appearance; stems and branches with a slightly differentiated cortex, lacking a scleroderm, and without fibrils or pores in the outer hyalodermal cells; long and short erect branches; large, imbricate stem leaves; large, club-shaped leaves of the short branches; hyaline cells of the leaves narrower on the abaxial surface than those on the adaxial surface; hyaline cells of leaves located on abaxial side of chlorophyllose cells in cross-section; in section, dimorphic chlorophyllose cells of the leaves of short branches; terminal perichaetia; perigonia lateral on the stem just below the perichaetium; and oblong-ellipsoidal antheridia.

Figure 7 (opposite). *Ambuchanania leucobryoides* (holotype). **A**, Stem *in situ* with only stem tips and capsule emergent from the substratum; **B**, Stem leaf; **C**, Leaf from upper part of long branch; **D**, Leaf from middle part of long branch; **E**, Upper leaf of short branch; **F**, Middle leaf of short branch; **G**, Lower leaf of short branch; **H**, **I**, Leaf cells from abaxial (H) and adaxial (I) surfaces of apical part of stem leaf; **J**, **K**, Abaxial surface of mid-leaf cells of stem leaf; **L**, **M**, Abaxial (L) and adaxial (M) surfaces of median cells of leaves of a short branch; **N**, **O**, T.S. of middle part of stem leaf; **P**, T.S. of upper leaf of short branch; **Q**, T.S. of apical part of upper leaf of short branch, showing ringed pores; **R**, T.S. of basal part of upper leaf of short branch, showing papillae on walls of chlorophyllose cells and intricate pore-like structures on abaxial surface of hyalocysts; **S**, Part of T.S. of short branch; **T**, Part of T.S. of stem. Scale bars: 5 mm for plant; 1 mm for leaves; 100 µm for cells and sections. Drawn by R.D.Seppelt. Reproduced with permission from *Hikobia* 13: 180, fig. 8 (2000). © Hikobia Botanical Society.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ANDREAEACEAE

Barbara M. Murray[1]

Andreaeaceae Dumort., *Ann. Fam. Pl.* 68 (1829).

Type: *Andreaea* Hedw.

Autoicous or dioicous. Plants perennial, acrocarpous, forming dark-pigmented (often black) cushions or turfs on acidic rock. Protonemata persistent and regenerate, complex, including a globose phase and ±terete rhizomatous axes bearing uniseriate or biseriate rhizoids and dorsiventral protonematal appendages. Stems lacking a central strand. Mucilage structures axillary. Juvenile leaves strongly differentiated, persistent. Mature leaves mostly concave abaxially, variable in shape and stance; costate leaves usually tapering from an abruptly formed shoulder of the sheathing base; ecostate leaves often ±panduriform due to a ±strongly contracted sinus separating blade from base; margin entire or not. Laminal cells variable, usually heterogeneous, distally often strongly collenchymatous, often papillose, usually unistratose, proximally often with thick pitted vertical walls. Perigonia gemmiform. Perichaetia usually strongly differentiated, with inner bracts convolute. Pseudopodium present. Calyptra apical, consisting largely of an unmodified archegonial neck with a delicate mitrate base, often falling early. Setae undeveloped. Capsules 3 emergent to exserted, elliptic or ovate, dehiscing by 4 or more dark-pigmented valves that reach neither apex nor base of capsule and which bulge outward, contracting and opening the capsule when dry. Spores small to large, often with a large percentage aborted and shrivelled.

This monotypic family comprises 50–75 species that are most common in cool-temperate regions; it is represented in Australia by 15 species. *Andreaea* species are often common, usually forming cushions that are black or blends of black and other dark hues (purple, brown, bronze, green or orange); growing on acidic rocks at high elevations in south-eastern Australia. The genus is most diverse in Tasmania.

Andreaea species with sheathing and convolute perichaetial bracts are traditionally placed in sect. *Nerviae* Cardot if they are costate and in sect. *Andreaea* if they are ecostate. This division is not tenable since some of the costate species appear to be more closely related to certain ecostate species than they are to each other (Murray, 1987). However, pending a revision of the entire family, it is premature to present a revised infrageneric classification of the Australian species.

In Australia, the taxonomically isolated *A. australis* (sect. *Chasmocalyx* Lindb. ex Braithw.) and *A. nitida* (placed in the monotypic sect. *Nitida* by Schultze-Motel, 1970) have not been troublesome and, for the most part, *A. subulata* and *A. alpina* have also been treated appropriately. Vitt (1980) clarified the taxonomy of *A. mutabilis* and suggested that *A. rupestris* Hedw. is not present in the Southern Hemisphere.

Many species are poorly known, and the 11 remaining taxa treated here have previously either not been recognised or have been misunderstood. As a result, in Australia, there has been no frame on which to build an understanding of the genus, and most literature pertinent to Australia has an almost entirely different context from that of the present treatment. Six species treated here are new to Australia: *A. flabellata*, *A. flexuosa*, *A. gainii*, *A. heinemannii*, *A. huttonii* and *A.* sp. Two others, *A. amblyophylla* and *A. microvaginata*, have not been recognised in Australia, or elsewhere, for over 80 years. On the other hand, *A. alpina*, *A. acuminata* and *A. acutifolia* have been accepted but almost completely misunderstood. Confusion in Australia and elsewhere has been caused by ignoring a stable and reliable character, spore size, and by relying on leaf characters that vary within species, e.g. the degree of crenation or toothing of basal margins, cell shape and wall thickenings.

[1] 1518 Moose Trail, Fairbanks, Alaska, AK 99709-6614, United States of America.

Measurements, except for those of stem length, are from material on slides mounted in Hoyer's solution. Descriptions apply to Australian material and, therefore, shoot length, leaf size, leaf papillosity and spore size may not reflect the full range of variation found elsewhere. Leaves refer to mature leaves that are not directly adjacent to juvenile or apical leaves. For leaves the term 'distal' refers to the region well above the shoulder or sinus, 'mid-leaf' refers to the vicinity of the sinus or shoulder, i.e. the area of transition from base to blade, and 'proximal' refers to the leaf base which is usually differentiated. Information on world distribution is based on specimens examined.

G.Roth, Andreaeaceae, *Aussereur. Laubm.* 1: 1–91, t. 1–10, 12 (1910–11); W.Schultze-Motel, Monographie der Laubmoosgattung *Andreaea*. I. Die costaten Arten, *Willdenowia* 6: 25–110 (1970); D.H.Vitt, A comparative study of *Andreaea acutifolia*, *A. mutabilis* and *A. rupestris*, *New Zealand J. Bot.* 18: 367–377 (1980); B.M.Murray, *Andreaea sinuosa*, *sp. nov.* (Musci: Andreaeaceae) from Alaska, British Columbia and Scotland, *Bryologist* 89: 189–194 ('1986') [1987]; B.M.Murray, Systematics of the Andreaeopsida (Bryophyta): Two orders with links to *Takakia*, *Beih. Nova Hedwigia* 90: 89–336 (1988); R.D.Seppelt, *The Moss Flora of Macquarie Island* 45–59 (2004).

ANDREAEA

Andreaea Hedw., *Sp. Musc. Frond.* 47 (1801); named for J.G.R.Andreae, an 18th century German apothecary.

Type: *A. rupestris* Hedw.

Description as for the family.

1 Leaves costate....................2

1: Leaves lacking a costa....................6

2 Costa rarely extending much distal to mid-leaf; leaves broadly oval to oblong....................**13. A. nitida**

2: Costa reaching or almost reaching leaf apex; leaves lanceolate or blade tapering from shoulder of oblong base....................3

3 Leaves lanceolate; costa well defined and not filling blade; perichaetial bracts not convolute, not or slightly sheathing *(2:)*....................**5. A. australis**

3: Leaves tapering from oblong base; costa often indistinct and filling much of blade; perichaetial bracts distinctly convolute and sheathing....................4

4 Margins of leaf base at least partly crenate to toothed from projecting ends of cells *(3:)*....................**11. A. microvaginata**

4: Margins of leaf base entire (rarely with a hint of crenation)....................5

5 Marginal cells in leaf base mostly isodiametric; base of capsule shorter than valves; costa mostly conspicuous in leaf base *(4:)*....................**14. A. subulata**

5: Marginal cells in leaf base mostly rectangular; base of capsule equal to or longer than valves; costa often weak or disappearing in leaf base....................**9. A. heinemannii**

6 Margins of leaf base at least partly crenate to toothed from projecting ends of cells *(1:)*....................7

6: Margins of leaf base entire....................11

7 Turgid spores mostly more than 35 µm diam. *(6)*....................8

7: Turgid spores mostly less than 30 µm diam.....................10

8 Leaves mostly 3–4 times as long as wide; leaf blade often falcate and secund; leaf apex unistratose; perigonial paraphyses absent *(7)*....................**2. A. acutifolia**

8: Leaves less than 3 times as long as wide; leaf blade straight, not or rarely secund; leaf apex locally bistratose distally; perigonial paraphyses present....................9

9 Proximal marginal cells oblique and crenate or toothed almost to insertion (occasionally the 1 or 2 most proximal marginal cells entire and erect); ±abrupt triangular area always present at apex, occupying a quarter or more the length of the leaf; distal laminal cells smooth or bulging *(8:)*....................**3. A. alpina**

9: Proximal marginal cells oblique and crenate or toothed mostly only near sinus, 4–16 most proximal cells entire and erect; ±abrupt triangular area, when present at apex, occupying less than one-fifth of the length of leaf; distal laminal cells usually indistinctly papillose.....................................**8. A. gainii**

10 Leaves ±panduriform, 2–3 times as long as wide; sinus strongly contracted; base distinctly sheathing *(7:)*.. **1. A. acuminata**

10: Leaves linear- to oblong-lanceolate, (4–) 5–6 (–7) times as long as wide; sinus not or barely contracted; base only slightly sheathing ....**6. A. flabellata**

11 Marginal cells in leaf base all isodiametric; leaf base not sheathing; sinus absent *(6:)* .. **12. A. mutabilis**

11: At least some marginal cells in leaf base rectangular; leaf base sheathing (very indistinctly in *A. flexuosa* and *A. flabellata*); sinus well defined...12

12 Leaf apex not cucullate (sometimes rounded) *(11:)* 13

12: Leaf apex (in at least some leaves) clearly cucullate 14

13 Leaf apex narrowly acute or acuminate, not rounded; margin incurved (blade appearing channelled to extreme apex); distal laminal cells locally (sometimes indistinctly) papillose, unistratose *(12)* ....**6. A. flabellata**

13: Leaf apex acute, often rounded; margin plane at and near apex; distal laminal cells smooth or bulging, often locally bistratose ....**7. A. flexuosa**

14 Leaf lamina with distinct often extensive bistratose patches; capsule base as long as valves; perigonial paraphyses present *(12:)* ....**14. Andreaea sp.**

14: Leaf lamina unistratose, very rarely with a minute (1 cell wide and long) bistratose layer; capsule base shorter than valves; perigonial paraphyses absent 15

15 Turgid spores mostly 44–50 µm diam.; leaves widest proximal and distal to sinus *(14:)*......................... ....**4. A. amblyophylla**

15: Turgid spores mostly 16–29 µm diam.; leaves widest in base..**10. A. huttonii**

1. Andreaea acuminata Mitt., *in* J.D.Hooker, *Fl. Tasman.* 2: 161, t. 171, fig. 2 (1859)

Andreaea acutifolia Hook.f. & Wilson subsp. *acuminata* (Mitt.) Vitt, *New Zealand J. Bot.* 18: 374 (1980). T: [Cheshunt], Tas., date unknown, *Archer s.n.*; holo: NY-Mitten; iso: BM-Hooker, HO 72251, 74076, 113025.

Andreaea erubescens Müll.Hal., *Hedwigia* 37: 79 (1898). T: Mt Wellington, Tas., Jan. 1889, *W.A.Weymouth s.n.*; lecto: H-BR ex Herb. C.Müller, *fide* B.M.Murray, *Fl. Australia* 51: 406 (2006).

Andreaea erubescens Müll.Hal. var. *nigrita* Müll.Hal., *Hedwigia* 37: 79 (1898). T: Mt Wellington, Tas., Jan. 1889, *W.A.Weymouth s.n.*; lecto: H-BR ex Herb. C.Müller, *fide* B.M.Murray, *Fl. Australia* 51: 407 (2006).

Stems 10–20 mm long. Leaves ±panduriform, 0.25–0.40 mm wide, equally wide in base and mid-leaf, 2–3 times as long as wide; blade rarely falcate, usually not secund, not flexuose; apex mostly slightly reflexed, narrowly acute or acuminate, not rounded, often with a ±abrupt terminal triangular area occupying a quarter (rarely more) of the length of the leaf; sinus strongly contracted; margin incurved, usually proximally crenate or toothed; base distinctly sheathing; costa absent; laminal cells heterogeneous, distally papillose and unistratose, proximally marginally mostly rectangular, often mostly oblique. Perigonial paraphyses absent. Perichaetial bracts convolute and sheathing. Capsule base shorter than valves. Turgid spores 16–25 µm diam.; shrivelled spores (14–) 16–21 µm diam.

Occurs in Tas.; also in New Zealand and apparently an Australasian endemic. Found primarily in rocky alpine summits at altitudes of 975–1561 m; grows on rock. Map 8.

Tas.: Ironstone Mtn, Dec. 1912, *L.Rodway s.n.* (HO); Mt Field, Dec. 1910, *L.Rodway s.n.* (HO); Mt Wellington, *W.W.Watts 261* (NSW, S); *loc. id.*, *W.A.Weymouth 261* (BM, HO, NSW); *loc. id.*, *W.A.Weymouth 1632* (NSW).

Andreaea acuminata is a rare plant known only from Tasmania and New Zealand. Reports by Mitten (*Philos. Trans. Roy. Soc. London* 168: 39, 1879) and others from other regions are based on misidentified specimens. Indeed, much of what has been named and reported from Australia as *A. acuminata* (especially crenate-denticulate, falcate-leaved material) is *A. acutifolia*. The two species can be readily distinguished when sporophytes are present; *A. acuminata* has turgid spores of c. 16–25 µm, while *A. acutifolia* has turgid spores that are mostly at least 32–50 µm. In the absence of capsules identification can be uncertain since leaf characters can vary within species. Typical *A. acuminata* has straight, panduriform

leaves 2–3 times as long as wide and often widest above or at the sinus; apices are ±abruptly formed, occupy c. a quarter of the length of the leaf, and distal cells are often triangular and wider than long from near the sinus to the apex. *Andreaea acutifolia* often has falcate and secund, indistinctly to obviously panduriform leaves that are clearly broadest near the insertion. The leaves tend to taper distally from the sinus, but when abruptly narrowed that distal portion tends to occupy about a third of the length of the leaf. The leaves of *A. acutifolia* have distal laminal cells that are usually (but not always) longer than wide.

Features that distinguish *A. acuminata* from *A. alpina* are discussed under the latter taxon. Moreover, the slightly reflexed, short leaf apices of *A. acuminata*, especially at the shoot tips, produce a characteristically spiky look that contrasts with *A. alpina* which usually has incurved leaf apices.

2. **Andreaea acutifolia** Hook.f. & Wilson, *London J. Bot.* 3: 535 (1844)

T: Hermite Is., Cape Horn [Chile], *J.D.Hooker 106B*; lecto: BM-Wilson, *fide* D.H.Vitt, *New Zealand J. Bot.* 18: 370 (1980); isolecto: BM-Hooker, BM-Wilson, NY-Mitten as *Wilson 107b*; Falkland Is., 1839–43, *J.D.Hooker*; syn: BM, FH; Auckland Is., 1839–43, *J.D.Hooker*; syn: *n.v.*; Campbell Is., 1839–43, *J.D.Hooker*; syn: BM, FH, NY.

Andreaea attenuata Müll.Hal., *Hedwigia* 37: 84 (1898); *A. amblyophylla* var. *attenuata* (Müll.Hal.) Rodway, *Pap. & Proc. Roy. Soc. Tasmania* 1913: 151 (1914). T: Mt Wellington, Tas., 1 Sept. 1891, *W.A.Weymouth 764 p.p.*; lecto: H-BR, *fide* B.M.Murray, *Fl. Australia* 51: 407 (2006); isolecto: HO 72278 *p.p.*

Illustration: R.D.Seppelt, *The Moss Flora of Macquarie Island* 47, fig. 18 (2004).

Stems 10–15 mm long. Leaves ±panduriform, 0.2–0.4 mm wide, widest in base or equally wide at base and in mid-leaf, 3–4 times as long as wide; blade often falcate, usually secund, not flexuose; apex often reflexed, narrowly acute or acuminate, not rounded; acumen (when present) ±abrupt, usually occupying one-third or more the length of the leaf); sinus ±strongly contracted; margin incurved, usually proximally crenate or toothed; base distinctly sheathing; costa absent; laminal cells heterogeneous, distally papillose and unistratose, proximally marginally mostly rectangular, often mostly oblique. Perigonial paraphyses absent. Perichaetial bracts convolute and sheathing. Capsule base shorter than valves. Turgid spores 32–50 (–60) µm diam.; shrivelled spores 20–38 µm diam.

Occurs in Vic. and Tas.; also in New Zealand, Macquarie Is., Auckland Is., Campbell Is. and southern South America. Found in alpine and subalpine heaths, open forest and woodland, on usually moist to wet rocks (granite, siltstone, sandstone) at altitudes of 700–1250 m. Map 9.

Vic.: Mt William, *I.G.Stone 7633* (MEL). Tas.: L. Dove, *R.D.Seppelt* 5697 (ADT); Mt Mawson, *I.G.Stone 3624* (MEL); Mt Rufus, 11 Dec. 1975, *C.Hone & G.Hone* (CANB); Mt Wellington, *W.A.Weymouth 1630* (BM, H-BR, HO, S).

Among type material no specimens were seen from the Auckland Islands. BM specimens with “Auckland Islands” printed on the label have that locality crossed out. Some type material from the Falkland Islands is *A. flexuosa*.

Most specimens examined were misidentified as *A. acuminata*, *A. rupestris* or *A. mutabilis*. *Andreaea acutifolia* is characterised by its large spores, usually panduriform and basally crenate-margined leaves and long, narrowly acute to acuminate apex. Differentiation from *A. acuminata* and *A. flabellata* is discussed under those species.

Problems remain with regard to *A. flabellata*, the type specimen examined being a rather poor specimen. The lectotype of *A. acutifolia* represents deficient material at an extreme of variation approaching *A. flabellata*. Further study is underway to permit better characterisation and delimitation of these taxa.

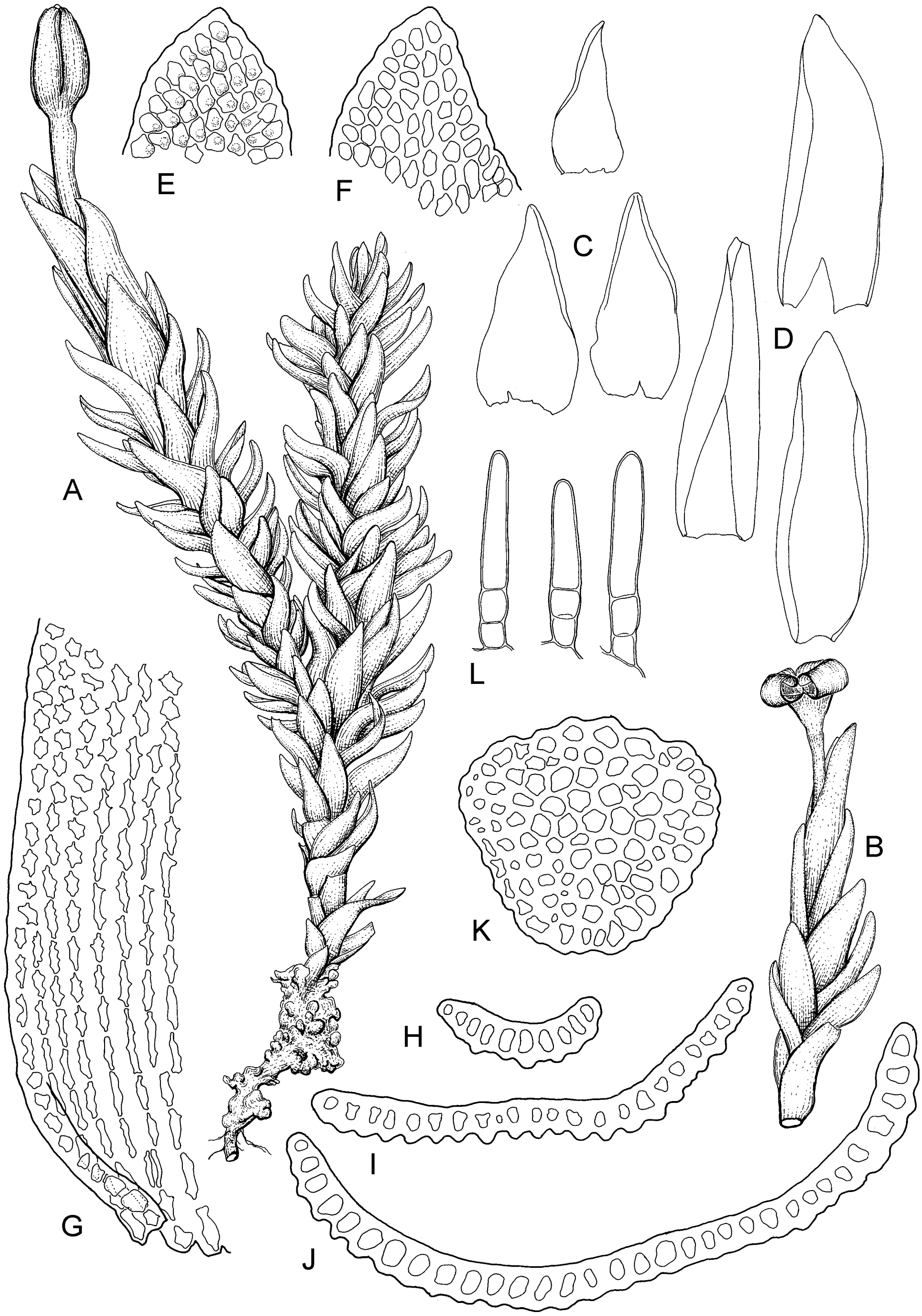

Figure 8. *Andreaea amblyophylla*. **A**, Habit (moist specimen); **B**, Sporophyte with dehisced capsule (dry specimen); **C**, Stem leaves; **D**, Perichaetial bracts; **E, F**, Cells at leaf apex; **G**, Cells of middle and lower leaf margin; **H–J**, T.S. of leaf from near apex to base; **K**, T.S. of stem; **L**, Axillary hairs (A–L, *B.M.Murray 93-13*, ALA). Drawn by R.D.Seppelt.

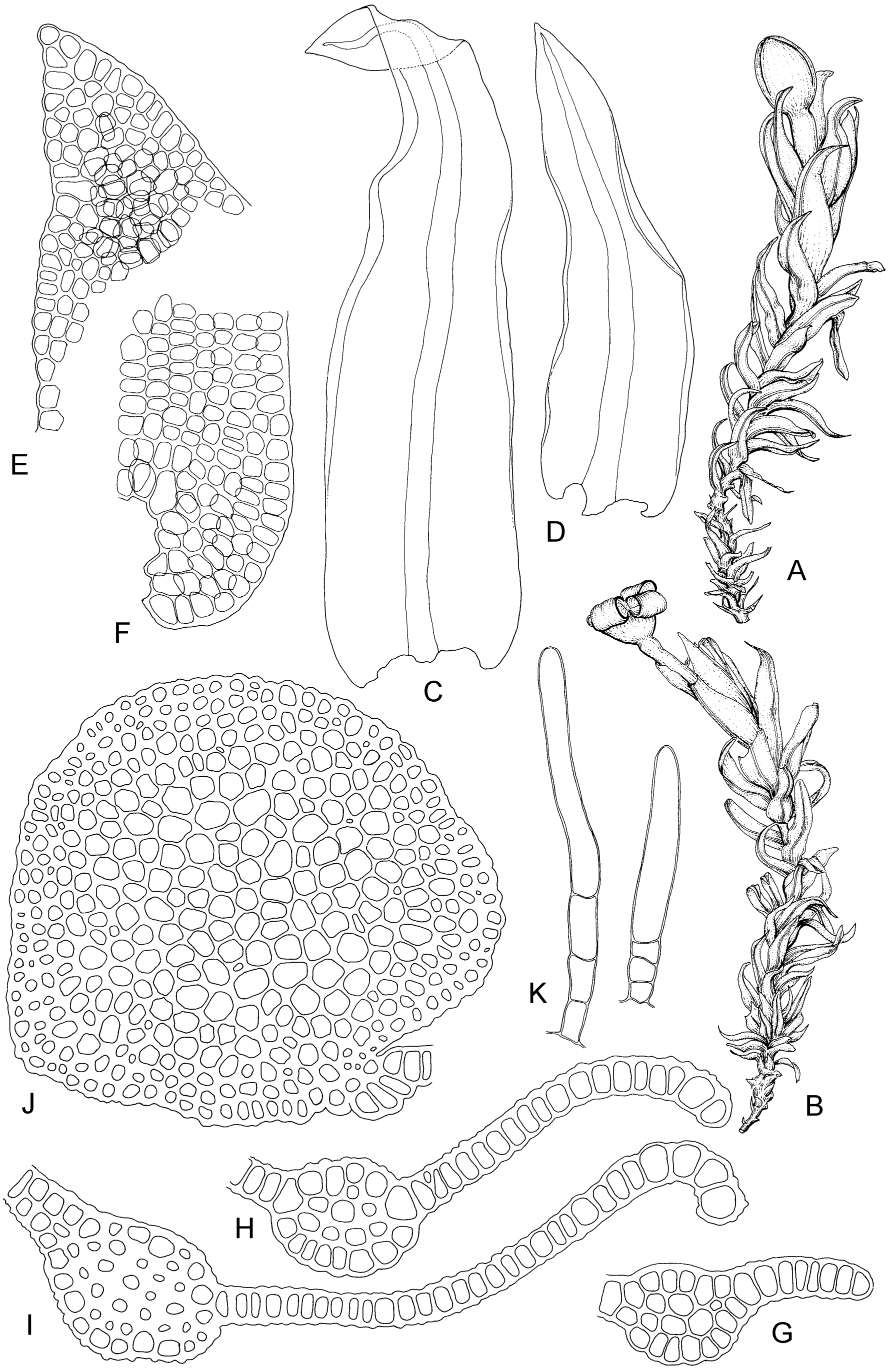

Figure 9. *Andreaea australis*. **A**, Habit (moist specimen); **B**, Sporophyte with dehisced capsule (dry specimen); **C**, Perichaetial bract; **D**, Stem leaf; **E**, Cells at leaf apex; **F**, Cells at corner of leaf base; **G–I**, T.S. of leaf from near apex to base; **J**, T.S. of stem; **K**, Axillary hairs (Specimen details not known.) Drawn by R.D.Seppelt.

3. **Andreaea alpina** Hedw., *Sp. Musc. Frond.* 49, t. 7, fig. 2p (1801)

T: Britain, Sweden, Bructeri, Germany, *coll. unknown*; syn: *n.v.*

Andreaea montana Mitt., *in* J.D.Hooker, *Fl. Tasman.* 2: 161, t. 171, fig. 1 (1859). T: near Cummings Head, Western Mtns, Tas., *A.C.Archer s.n.*; holo: NY-Mitten; iso: BM-Hooker, HO 74488.

Illustrations: B.M.Murray, *Meddel. Grønland, Biosci.* 23: 14, fig. 6 (1987); B.M.Murray, *J. Bryol.* 15: 58, fig. 15a–k (1988); R.D.Seppelt, *The Moss Flora of Macquarie Island* 49, fig. 19 (2004).

Stems 1–6 (–8) cm long. Leaves panduriform, mostly 0.4–0.5 mm wide, widest in mid-leaf, 2–2.5 times as long as wide; blade straight, usually not secund, sometimes flexuose; apex usually inflexed or plane, acute, not rounded, with a ±abrupt broad terminal triangular area occupying 25–33 (–50)% of the length of the leaf; sinus strongly contracted; margin incurved to plane, proximally crenate or toothed (1 or 2 most proximal cells sometimes entire); base distinctly sheathing; costa absent; laminal cells heterogeneous, distally smooth (or slightly bulging), locally bistratose or unistratose, proximally marginally mostly rectangular, mostly oblique. Perigonial paraphyses present. Perichaetial bracts convolute and sheathing. Capsule base shorter than valves. Turgid spores 26–58 µm diam.; shrivelled spores 17–48 µm diam.

Occurs in Tas., usually in alpine heaths, tussock grassland and shrubland, also in subalpine shrub communities, on wet cliff faces and flushed rocks at altitudes of 700–1590 m. Widely distributed in the Southern Hemisphere: New Zealand, Macquarie Is., Auckland Is., Kerguelen Is., Gough Is., Marion Is., Tristan da Cunha, South Georgia, Falkland Is. and South America; also in north-western Europe and Greenland. Map 10.

Tas.: Hartz Mtns, 8 Jan. 1908, *E.J.Mitchell s.n.* (HO); Mt Barrow, *D.H.Norris 33770* (ALTA, CANB, HO, MICH); Mt Laperouse, *A.F.Oldfield s.n.* (BM, HO 74089, S); Falls, Mt Wellington, *R.A.Bastow 339* (FH, HO, MEL); between Naturalist Peak and Mt Field West, 12 Dec. 1952, *J.H.Willis s.n.* (MEL).

Andreaea alpina, along with *A. acuminata* and *A. gainii*, are rare species that are known in Australia only from Tasmania. They can grow in similar habitats and all have leaf base margins that are crenate or toothed; *A. acuminata* and *A. gainii* also tend to have leaves with abruptly formed, triangular apices similar to those of *A. alpina*. Most collections of *A. alpina* have been misidentified as *A. acuminata*, but *A. alpina* differs by its usually stiffer, more symmetrical leaves with a more sharply formed, characteristically incurved, triangular apex. It also has much larger spores, and male plants have numerous paraphyses. *Andreaea alpina* differs from the very rare *A. gainii* by its leaves with basal marginal cells oblique and crenate or toothed almost to the insertion. It also tends to have leaves with basal median cell lumina clearly narrower than the walls and with a more abruptly formed apex.

Until an analysis of the significance of the considerable variability, worldwide, of *A. alpina* is completed, *A. montana* is best treated as a synonym. It differs from *A. alpina s. str.* by its larger range of spore size and leaves that can sometimes be less stiff with longer, more secund apices.

4. **Andreaea amblyophylla** Müll.Hal. ex Broth., *Oefvers. Förh. Finska Vetensk.-Soc.* 37: 149 (1895)

T: Knocklofty, N of Salvator Rosa Glen, near Hobart, Tas., 19 Aug. 1893, *W.A.Weymouth 1618*: lecto: H-BR, *fide* B.M.Murray, *Fl. Australia* 51: 407 (2006); isolecto: BM, NSW 211189, NSW M11165, NY; Blue Mtns, N.S.W., *T.Whitelegge 302*; syn: H-BR, MEL, NSW; Knocklofty, near Hobart, Tas., *W.A.Weymouth 262*; syn: BM, H-BR, HO; *loc. id.*, *W.A.Weymouth 475*; syn: BM, CANB, H-BR, HO; *loc. id.*, *W.A.Weymouth 476*; syn: H-BR, HO; *loc. id.*, *W.A.Weymouth 477*; syn: CANB, H-BR, HO; *loc. id.*, *W.A.Weymouth 1618(a)*; syn: H-BR; Mt Wellington, Tas., *W.A.Weymouth 1634*; syn: H-BR; *loc. id.*, *W.A.Weymouth 1635*; syn: BM, H-BR, HO; *loc. id.*, *W.A.Weymouth 1643*; syn: H-BR, HO.

Stems 5–10 mm long. Leaves lanceolate or oblong-lanceolate (indistinctly panduriform), 0.2–0.4 mm wide, equally wide in base and mid-leaf, mostly 2.5–3.5 times as long as wide; blade straight, sometimes flexuose; apex usually cucullate, sometimes acute, rounded or not, not abruptly formed; sinus barely contracted; margin incurved, entire; base ±distinctly sheathing; costa absent; laminal cells heterogeneous, distally papillose and unistratose, proximally marginally isodiametric and rectangular, erect. Perigonial paraphyses absent.

Perichaetial bracts convolute and sheathing. Capsule base shorter than valves. Turgid spores 44–50 µm diam.; shrivelled spores c. 32 µm diam. Fig. 8.

Occurs in W.A., N.S.W., A.C.T., Vic. and Tas.; also in New Zealand. Found in alpine heaths and scrub and subalpine and lower *Eucalyptus*-dominated grassland, woodland and open to closed forest; on rocks (granite, dolerite, rhyolite and sandstone) at altitudes of 305–1600 m. Map 11.

W.A.: track to Toolbrunup Peak [40 km SW of Borden], *H.Streimann 54520* (CANB). N.S.W.: Point Lookout, *I.G.Stone* 14076 (MEL). A.C.T.: Mt Clear, *H.Streimann 10590* (CANB). Vic.: Mt William, *B.M.Murray 93-9* (ALA). Tas.: Hartz Mtns, *W.A.Weymouth 2297* (BM, CANB, HO, NY).

Among ecostate taxa, this is second only to *A. mutabilis* in terms of number of specimens seen and the breadth of habitat range. The record from W.A. is the first for the genus from that State.

Large spores separate *A. amblyophylla* from other species with cucullate leaf apices, e.g. *Andreaea* sp. and *A. huttonii*. Some specimens have many leaves that are not cucullate, and this, together with its primarily isodiametric proximal leaf cells, can cause confusion with *A. mutabilis*. However, close examination always shows some rectangular proximal cells, usually some cucullate apices and, of course, large spores in *A. amblyophylla*. Ongoing research indicates that *A. amblyophylla* may occur outside Australasia.

5. Andreaea australis Mitt., *Hooker's J. Bot. Kew Gard. Misc.* 8: 257 (1856)

T: Munyang Mtns, Vic., *F.Mueller 23*; syn: MEL; syn: FH, K, NSW, NY, UPS *n.v.*, *fide* W.Schultze-Motel, *Willdenowia* 6: 90 (1970); *F.Mueller 85*; syn: MEL; Australian Alps, Vic., *F.Mueller 16*; syn: MEL.

Illustrations: W.Schultze-Motel, *Willdenowia* 6: 43–45, figs 3–5 (1970).

Stems 1–12 cm long. Leaves lanceolate, 0.4–1.5 mm wide, widest in base, 2–3 times as long as wide; blade usually slightly curved, usually not secund, often somewhat flexuose; apex variably flexed, acute, rounded or not, sometimes mucronate; sinus absent; margin usually partially reflexed or revolute, entire; base not distinctly sheathing; costa conspicuous from leaf apex to base, not filling blade; laminal cells ±homogeneous, distally smooth or papillose and unistratose or rarely locally bistratose, proximally marginally isodiametric, not oblique. Perigonial paraphyses usually absent. Perichaetial bracts not convolute, not or slightly sheathing. Capsule base shorter than valves. Turgid spores 28–30 (–36) µm diam.; shrivelled spores 20–24 µm diam. Fig. 9.

Occurs in N.S.W., A.C.T., Vic., Tas.; also in New Zealand, Macquarie Is., Auckland Is. and South Georgia. Found in alpine and subalpine grassland, heath and herbfield and in stunted *Eucalyptus* woodland at altitudes of 1160–2180 m; on wet or shaded rock surfaces, very rarely on the ground. Map 12.

N.S.W.: Blue L. [7 km NE of Mt Kosciuszko], *H.Streimann 9597* (ALTA, CANB, CHR, FH, HO); Mt Kelly, *H.Streimann 49150* (CANB). A.C.T.: Sentry Box, *J.A.Curnow*, *H.Lepp & M.Brenan 582* (CANB, FH). Vic.: “Ruined Castle”, 16.5 km SSE of Mt Beauty, *I.G.Stone 2146* (MEL). Tas.: Whymper Crag, *A.V.Ratkowsky H753* (CANB, HO).

Like *A. nitida*, *A. australis* is a taxonomically isolated species. Locally common in suitable habitats in mainland Australia but rare in Tasmania, it is readily distinguished by its lanceolate leaves and the long costa that is strongly delineated and not filling the blade.

6. Andreaea flabellata Müll.Hal., *Bot. Jahrb. Syst.* 5: 76 (1883)

T: Kerguelen Is., Dec. 1874, *F.C.Naumann*; iso: BM.

Illustration: R.D.Seppelt, *The Moss Flora of Macquarie Island* 51, fig. 20 (2004).

Stems 5–10 (–15) mm long. Leaves linear- to oblong-lanceolate, 0.20–0.25 mm wide, widest in base, (4–) 5–6 (–7) times as long as wide; blade usually straight, usually not secund, flexuose; apex variably flexed, narrowly acute or acuminate, not rounded, not abruptly formed; sinus not or barely contracted; margin incurved, proximally entire or rarely crenate; base not or slightly sheathing; costa absent; laminal cells heterogeneous, distally papillose

(sometimes inconspicuously or irregularly so) and unistratose, proximally marginally mostly rectangular, if oblique usually indistinctly so. Perigonial paraphyses absent. Perichaetial bracts convolute and sheathing. Capsule base shorter than valves. Turgid spores 21–35 µm diam.; shrivelled spores 15–24 µm diam.

Occurs in N.S.W., A.C.T., Vic., Tas.; also in Macquarie Is., Campbell Is., New Zealand, Kerguelen Is., Heard Is., Tristan da Cunha and southern South America. Grows in alpine and subalpine heath and *Eucalyptus*-dominated grassland, on cliffs and rocks (granite and dolerite) at 900–1875 m. Map 13.

N.S.W.: Charlotte Pass, *B.M.Murray 92-186* (ALA). A.C.T.: Mt Gingera, *H.Streimann 3492* (CANB, NY). Vic.: The Peak, near Wulgulmerang, Wombargo Ra., 4 Dec. 1962, *J.H.Willis s.n.* (MEL). Tas.: Mt Wellington, Nov. 1947, *N.A.Burges s.n.* (LIV); *loc. id*., *B.M.Murray 93-31* (ALA).

Andreaea flabellata is rare and is reported here for the first time from Australia, specimens having been previously misidentified as *A. rupestris*, *A. mutabilis* or *A. acutifolia*. This taxon differs from *A. acutifolia* by having leaves that are usually entire, narrow and 4–7 times as long as wide, with a weakly or non-contracted sinus and a very inconspicuously sheathing leaf base. *Andreaea flabellata* also has smaller spores, usually less than 30 µm diam. It can be distinguished from *A. flexuosa* by leaves that are at least partly papillose, concave or channelled abaxially to near the apex, and narrowly acuminate and less twisted toward the apex.

7. Andreaea flexuosa R.Br.bis, *Trans. Proc. New Zealand. Inst.* 25: 279, pl. 23 (1893)

T: Moa Creek, New Zealand, June 1885, *R.Brown*; lecto: BM-Dixon, *fide* B.M.Murray, *Fl. Australia* 51: 407 (2006); Arthur's Pass, New Zealand, June 1884, *R.Brown*; syn: *n.v.*

Stems 2.5–5.0 (–9.0) mm long. Leaves linear-lanceolate, 0.20–0.25 mm wide, widest in base, 5–8 times as long as wide; blade straight, strikingly flexuose-twisted (especially when moist); apex plane (sometimes broken off), acute, often rounded, not abruptly formed; sinus not or barely contracted; margin distally plane, proximally incurved, entire; base not distinctly sheathing; costa absent; laminal cells heterogeneous, distally bulging or smooth and unistratose or locally bistratose, proximally marginally mostly rectangular, erect. Perigonial paraphyses absent. Perichaetial bracts convolute and sheathing. Capsule base shorter than or equal to valves. Turgid spores 22–32 µm diam.; shrivelled spores 18–22 µm diam. Fig. 10.

Occurs in N.S.W., A.C.T., Vic. and Tas.; also in New Zealand, New Guinea, Madagascar, southern Africa, Gough Is., Tristan da Cunha, Falkland Is., southern South America, Hawai'i and Madeira. Found in alpine and subalpine heath, grassland, shrubland and herbfield, more rarely in open forest; on exposed, or more rarely shaded cliff faces and boulders (basalt, granite and dolerite) at altitudes of 900–1790 m. Map 14.

N.S.W.: Rocky Plains Ck, [23 km NW of Adaminaby], *H.Streimann 45311* (CANB). A.C.T.: Mt Aggie [38 km SW of Canberra], *B.M.Murray 92-179* (ALA). Vic.: Mt William, *I.G.Stone 26035* (MEL). Tas.: Mt Wellington, *W.W.Watts 169* (H-BR, NSW).

It is surprising that *A. flexuosa* has not been recognised in Australasia since its description more than a century ago, because it is unvarying, distinctive, widespread and locally common. Specimens examined were misidentified as *A. rupestris*, *A. acutifolia* or *A. mutabilis*. However, *A. flexuosa* is characterised by its growth form (characteristically very low, scarcely branched stems forming velvety black turfs) and the combination of narrow, scarcely sheathing, epapillose leaves with plane, ribbon-like, flexuose-twisted leaf blades and rather broad, often rounded (but not cucullate) apices. Features that distinguish *A. flexuosa* from *A. flabellata* are discussed under the latter species. Some specimens of *A. flexuosa* have very thick, locally bistratose distal blades.

While *A. flexuosa*, *A. acutifolia* and *A. flabellata* are all widespread in the Southern Hemisphere, past misidentifications and inadequate study preclude a thorough understanding of their distribution.

8. Andreaea gainii Cardot, *Compt. Rend. Hebd. Séances Acad. Sci.* 153: 602 (1911)

T: Cap Tuxen, Terre de Graham [Graham Land], Antarctica, 8 Jan. 1909, *Gain 209*; iso: BM, H-BR, NY, S.

Illustration: R.D.Seppelt, *The Moss Flora of Macquarie Island* 53, fig. 21 (2004).

Stems 7–15 mm long. Leaves panduriform, 0.25–0.40 mm wide, widest in mid-leaf or equally wide in base and mid-leaf, to twice as long as wide; blade straight, not flexuose; apex inflexed, broadly acute, not rounded, a ±abrupt broad triangular area, when present, rarely occupying more than 20% of the length of leaf; sinus strongly contracted; margin incurved to plane, proximally mostly entire, crenate or toothed only near sinus; base distinctly sheathing; costa absent; laminal cells heterogeneous; distally usually inconspicuously papillose and unistratose or locally bistratose, proximally marginally mostly rectangular; 4–16 most proximal cells not oblique, those near sinus often oblique. Perigonial paraphyses present. Perichaetial bracts convolute and sheathing. Capsule base shorter than valves. Turgid spores 32–50 (–60) µm diam.; shrivelled spores 22–32 (–50) µm diam.

Occurs in Tas.; also in Macquarie Is., Marion Is., Prince Edward Is., Bouvet Is., South Georgia, South Orkney Is., South Shetland Is., South Sandwich Is., Antarctica and southern South America. Collected at elevations of 850–1225 m from mountain summit and tall heath communities and from submerged rock at a lake margin. Map 15.

Tas.: Hartz Mtns, *B.M.Murray 93-65* (ALA); Mt Wellington, Nov. 1910, *L.Rodway s.n.* (HO).

Andreaea gainii is reported here for the first time from Australia; it is extremely rare, being found at only two localities and associated with *A. subulata* at both. Differences between it and *A. alpina* are discussed under that species. Further study of the *A. alpina* complex, including *A. gainii* and closely related taxa found outside Australia, is necessary.

9. Andreaea heinemannii Hampe & Müll.Hal., *Bot. Zeitung (Berlin)* 4: 324, t. 2, figs 1–18 (1846), as *heinemanni*

T: Grimsel, Switzerland, 8 Sept. 1844, *Heinemann*; holo: BM-Hampe; iso: BM.

Illustration: B.M.Murray, *Meddel. Grønland, Biosci.* 23: 12, fig. 5 (1987).

Stems rarely more than 2.5 mm long. Leaves with blade tapering from an oblong base, 0.3–0.4 mm wide, widest in base, 3–7 times as long as wide; blade straight to falcate, sometimes secund, often slightly flexuose; apex variably flexed, narrowly acute or acuminate, not rounded, not abruptly formed; sinus absent; margin plane, entire; base distinctly sheathing; costa present, conspicuous from leaf apex to base or weak in base, filling distal half of blade or more; laminal cells heterogeneous, distally smooth or bulging, bistratose (at margin usually unistratose), proximally marginally rectangular to isodiametric, not oblique. Perigonial paraphyses very rare. Perichaetial bracts convolute and sheathing. Capsule base equal to or longer than valves. Turgid spores 23–32 (–36) µm diam.; shrivelled spores 22–27µm diam. Fig. 11.

Occurs in N.S.W. and Vic.; also in New Zealand and Kerguelen Is., but primarily a Northern Hemisphere species in southern Europe, Caucasus, Macaronesia, Greenland, western North America. Grows on exposed basalt in subalpine heath at altitudes of 1660–1750 m. Map 16.

N.S.W.: Round Mtn [28 km NE of Khancoban], *H.Streimann & J.A.Curnow 35166* (CANB). Vic.: Alpine Rd, 34 km WNW of Omeo, *B.M.Murray 92-208* (ALA); Basalt Hill, between heads of Middle Ck and Rocky Valley, *J.H.Willis 40* (LIV, MEL, WELT); “Ruined Castle”, 16.5 km SSE of Mt Beauty, *I.G.Stone 2155* (MEL); Weeping Rock, 4.2 km E of Hotham on Omeo–Hotham road, *I.G.Stone 2288* (MEL).

Andreaea heinemannii does not appear to be closely related to other Australian species. It was only recently recognised as occurring outside southern Europe (B.M.Murray, *Meddel. Grønland, Biosci.* 23: 6–24, 1987) and is new to Australia and the Southern Hemisphere. Its distribution is limited, but it can be locally abundant in its primary habitat (exposed basalt at high elevations). The association with basalt also occurs outside Australia. Collections have been misidentified as *A. subulata* from which *A. heinemannii* is easily distinguished by its specialised habitat, very short, black turfs and leaves with longer blades and mostly rectangular cells at the proximal margins. The capsules stand out against the black leaves, and have pale bases as long as or longer than the valves.

10. Andreaea huttonii R.Br.bis, *Trans. & Proc. New Zealand Inst.* 25: 279, t. 23 *p.p.* (1893), as *huttoni*

T: Moa Ck, New Zealand, June 1885, *R.Brown*; lecto: BM-Dixon, *fide* B.M.Murray, *Fl. Australia* 51: 408 (2006); isolecto: BM-Dixon, BM ex Cardot, CHR 335634 transferred to CANB, H-BR.

Stems 5–12 mm long. Leaves linear-lanceolate, 0.2–0.4 mm wide, widest in base, 3–5 times as long as wide; blade straight, not flexuose; apex cucullate, broadly acute, rounded, not abruptly formed; sinus barely contracted; margin incurved, entire; base ±distinctly sheathing; costa absent; laminal cells heterogeneous, distally papillose and unistratose, proximally marginally mostly rectangular, erect. Perigonial paraphyses absent. Perichaetial bracts convolute and sheathing. Capsule base shorter than valves. Turgid spores 16–29 µm diam.; shrivelled spores 13–18 µm diam.

One collection is known from an unspecified habitat in Tas.; also in New Zealand where it occurs in alpine heath and subalpine heath grassland, scrub and *Nothofagus* rainforest communities, usually on exposed rock (granite and greywacke) at 680–1150 m. Map 17.

Tas.: Cradle Mtn, Dec. 1916, *L.Rodway s.n.* (HO).

This moss is known from a single collection made over 90 years ago. It is striking because of its cucullate leaf apices and, therefore, it has possibly been confused with *A. amblyophylla* and *Andreaea* sp. *Andreaea huttonii* has much smaller spores and glossier leaves, attributable to smaller, less dense papillae than in *A. amblyophylla*. It differs from *A.* sp. by its unistratose leaves and exposed habitat. Here treated as an Australasian endemic, it appears to be related to *A. laxifolia* Hook.f. & Wilson from southern South America.

11. Andreaea microvaginata Müll.Hal., *Hedwigia* 37: 80 (1898)

T: Kelly’s Ra., Westland, South Is., New Zealand, 10 May 1889, *T.W.N.Beckett s.n.*; lecto: H-BR ex Herb. C.Müller, *fide* B.M.Murray, *Fl. Australia* 51: 408 (2006); isolecto: S.

Andreaea tasmanica Rodway, *Pap.* & *Proc. Roy. Soc. Tasmania* 1915: 95 (1916). T: Cradle Mtn, Tas., Dec. 1915, *L.Rodway s.n.*; lecto: HO 74062, *fide* B.M.Murray, *Fl. Australia* 51: 408 (2006); isolecto: HO 522113.

Stems (5–) 10–20 mm long. Leaves with blade tapering from an oblong base, 0.2–0.3 mm wide, widest in base or equally in base and mid-leaf, 3–4 times as long as wide; blade usually falcate, secund, often flexuose; apex variably flexed, acute, not rounded, not abruptly formed; sinus barely contracted; margin plane to incurved, proximally crenate or toothed; base distinctly sheathing; costa ±conspicuous from leaf apex to base or weak in base, ±filling distal quarter of blade; laminal cells heterogeneous, distally usually smooth and mainly bistratose, proximally marginally rectangular to isodiametric, mostly oblique. Perigonial paraphyses present. Perichaetial bracts convolute and sheathing. Capsule base shorter than valves. Turgid spores 20–35 µm diam.; shrivelled spores c. 18 µm diam.

Occurs in N.S.W., A.C.T., Vic. and Tas.; also in New Zealand, and apparently an Australasian endemic. Most common in alpine heaths, shrubland and grassland, also in wet subalpine and sclerophyll forest, on shaded to exposed, wet to moist, or occasionally dry, acidic rock surfaces and rocky or peaty soil, at altitudes of 750–1820 m. Map 18.

N.S.W.: Cambewarra Mtn, above Baldys, *W.W.Watts 9959* (H, NSW). A.C.T.: Mt Kelly, *H.Streimann 49128* [*Musci Australas. Exsicc.* 167] (CANB). Vic.: “Ruined Castle”, 16.5 km SSE of Mt Beauty, *I.G.Stone 7952* (MEL). Tas.: Arve Falls, *D.H.Norris 29778* (ALTA, CANB, HO, MICH, MO); Land of Little Sticks, *M.G.Noble 28571* (CANB, HO).

Andreaea microvaginata is a distinctive and rather common costate species (notwithstanding the original descriptions by Müller and Rodway as being ecostate). However, it has been overlooked in Australia since the early 1900s. Its leaves, with crenate-denticulate proximal margins, an often indistinct costa, falcate and secund stance and its robust cushion habit are no doubt responsible for misidentifications as the ecostate *A. acutifolia* and, more rarely, *A. acuminata*, both of which sometimes form mixed colonies with it. Its proximal leaf margins with projecting cell ends forming crenations and teeth and the development of a sinus relate *A. microvaginata* to ecostate taxa in Australia with similar features, viz. *A. acuminata*, *A. acutifolia*, *A. alpina*, *A. gainii* and possibly *A. flabellata*.

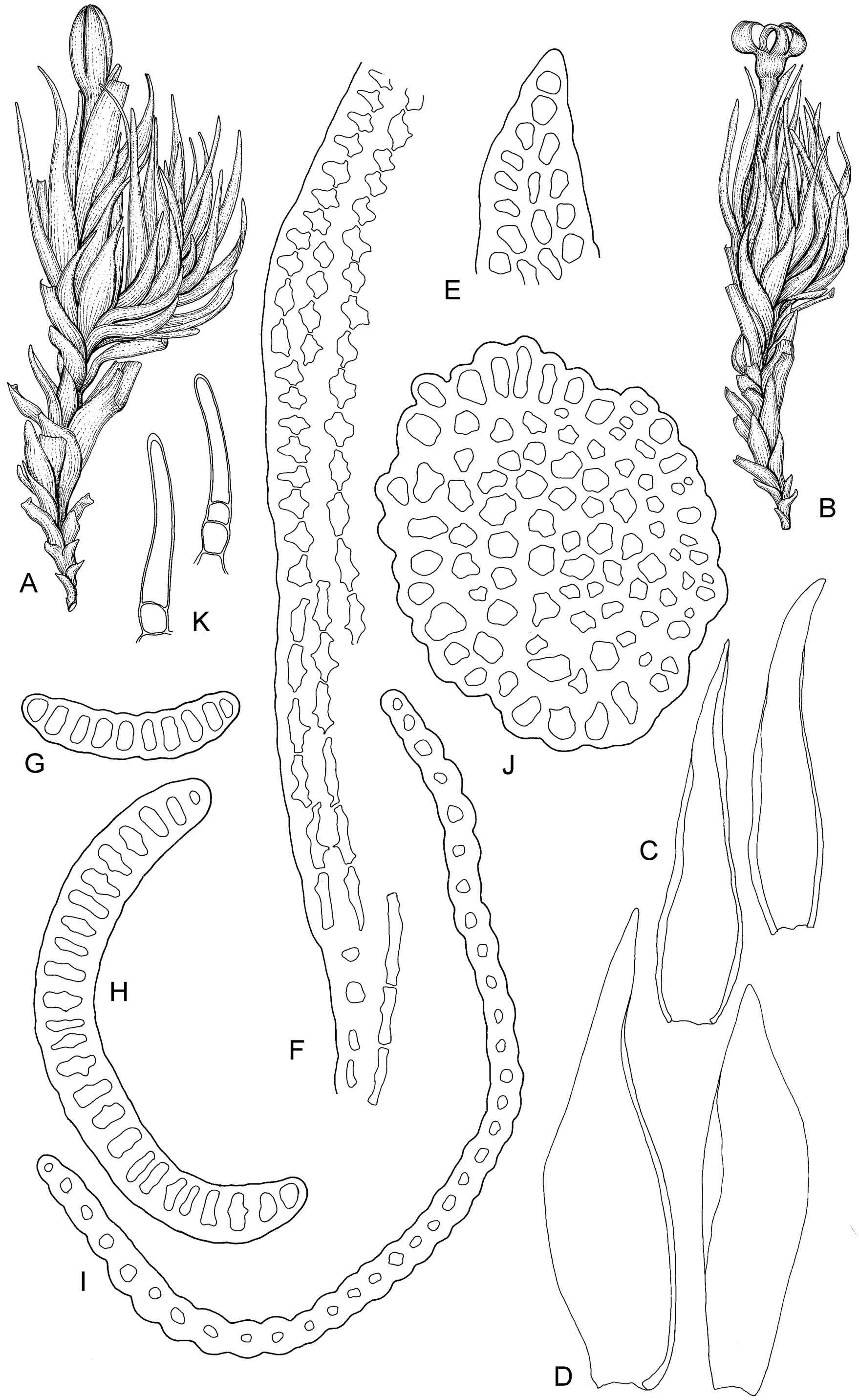

Figure 10. *Andreaea flexuosa*. **A**, Habit (moist specimen); **B**, Sporophyte with dehisced capsule (dry specimen); **C**, Stem leaves; **D**, Perichaetial bracts; **E**, Cells at leaf apex; **F**, Cells of middle and lower leaf margin; **G–I**, T.S. of leaf from near apex to base; **J**, T.S. of stem; **K**, Axillary hairs (A–K, *A.R.Perry 9291/1–7*, ALA). Drawn by R.D.Seppelt.

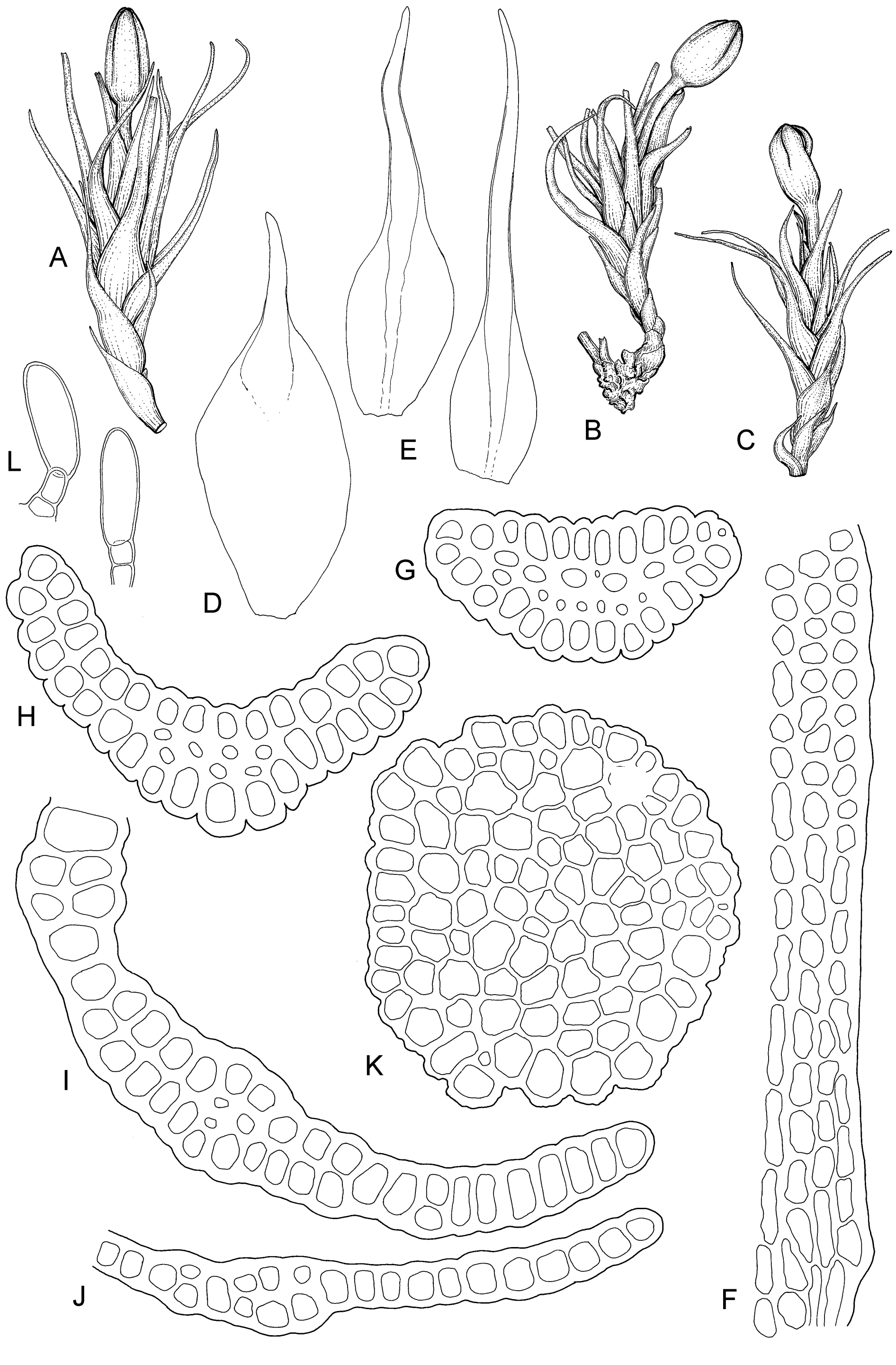

Figure 11. *Andreaea heinemannii*. **A–C**, Habit, showing sporophytes; **D**, Perichaetial bracts; **E**, Stem leaves; **F**, Cells of leaf margin; **G–J**, T.S. of leaf from near apex to base; **K**, T.S. of stem; **L**, Axillary hairs. (A–L, *B.M.Murray, A.R.Perry & H.Streimann s.n.*, ALA B0027433). Drawn by R.D.Seppelt.

12. **Andreaea mutabilis** Hook.f. & Wilson, *London J. Bot.* 3: 536 (1844)

T: Auckland Is., *J.D.Hooker*; lecto: BM-Wilson, *fide* D.H.Vitt, *New Zealand J. Bot.* 18: 370 (1980); isolecto: BM, FH; Campbell Is., *J.D.Hooker*; syn: BM, FH.

Andreaea asperula Mitt., *J. Proc. Linn. Soc., Bot.* 4: 65 (1860). T: Australian Alps, 1855, *F.Mueller 14 p.p.*; holo: NY-Mitten; iso: BM-Hooker, MEL 1033454, NY? (probable isotype, but *in sched.* as *A. mulleri* and lacking number), UPS; *synon. nov.*

Andreaea julicaulis Müll.Hal., *Hedwigia* 37: 79 (1898). T: Mt Wellington, Tas., 1 Sept. 1891, *W.A.Weymouth 263 p.p.*; lecto: H-BR, *fide* B.M.Murray, *Fl. Australia* 51: 408 (2006); *synon. nov*.

Andreaea tenera Müll.Hal., *Hedwigia* 37: 84 (1898). T: Nellies Glen, Katoomba, Blue Mtns, N.S.W., 5 Oct. 1891, *T.Whitelegge 430*; lecto: H-BR, *fide* B.M.Murray, *Fl. Australia* 51: 409 (2006); isolecto: NSW M11168, S; *synon. nov*.

Andreaea amblyophylla var. *bullata* Rodway, *Pap. & Proc. Roy. Soc. Tasmania* 1913: 151 (1914). T: Mt Wellington, Tas., Dec. 1913, *L.Rodway s.n.*; lecto: HO 72280 *p.p.*, *fide* B.M.Murray, *Fl. Australia* 51: 409 (2006); *synon. nov*.

Illustrations: D.H.Vitt, *New Zealand J. Bot.* 18: 373, figs 17–22 (1980); B.M.Murray, *J. Bryol.* 15: 66, fig. 19a–k (1988); R.D.Seppelt, *The Moss Flora of Macquarie Island* 55, fig. 22 (2004).

Stems (2–) 6–9 (–30) mm long. Leaves lanceolate, c. 0.35 mm wide, widest in base, 2–3 times as long as wide; blade straight to falcate, secund or not, not flexuose; apex incurved (plane only at extreme apex), narrowly acute or acuminate, not rounded, not abruptly formed; sinus absent; margin incurved (plane only at extreme apex), entire (rarely appearing slightly crenate proximally from projecting papillae); base not distinctly sheathing; costa absent; laminal cells heterogeneous, distally papillose and usually unistratose, proximally marginally isodiametric, erect. Perigonial paraphyses usually absent. Perichaetial bracts convolute and sheathing. Capsule base shorter than valves. Turgid spores 12–24 (–32) µm diam.; shrivelled spores rare, 12–20 µm diam. Plate 2.

Occurs in Qld, N.S.W., A.C.T., Vic. and Tas.; also in New Zealand, Macquarie Is., Auckland Is., Campbell Is., New Guinea, Indonesia, Taiwan, Kerguelen Is., southern Africa, Tristan da Cunha, Falkland Is., South America, north-western North America, Faeroes and western Europe. Found in alpine and subalpine heath, grassland, shrubland, woodland and forest, often *Eucalyptus*-dominated; on wet to dry outcrops and boulders (granite, granodiorite, basalt, sandstone and shale) at altitudes of 150–2150 m. Map 19.

Qld: South Bald Rock, *I.G.Stone 13509* (MEL). N.S.W.: Big Badja Mtn, *H.Streimann 5575* (ALTA, BM, CANB, CHR, H, L, NY). A.C.T.: Mt Bimberi, *H.Streimann 4397* (CANB, H, L, NY). Vic.: Double-headed Mtn, Black Ra., *A.C.Beauglehole 9380* (MEL). Tas.: Molly Yorks Night Cap, *A.Moscal 19017* (HO).

Andreaea mutabilis is the most common *Andreaea* species in Australia and the only one known from Queensland. It is unmistakable due to its ecostate leaves that diverge from the insertion (lacking a sheathing base and sinus development), have isodiametric, proximal marginal cells, an apex that is never cucullate and small spores. Leaf size and stance in *A. mutabilis* vary from very small and straight to long, falcate and secund. *Andreaea amblyophylla*, which can have leaves with most, but never all, proximal marginal cells isodiametric, differs from *A. mutabilis* by having straight leaves with a sheathing base, a developed sinus, apices usually cucullate (at least in some leaves) and large spores.

13. **Andreaea nitida** Hook.f. & Wilson, *London J. Bot.* 3: 535 (1844)

T: Auckland Is., 1839–43, *J.D.Hooker 52*; lecto: BM-Wilson, *fide* B.M.Murray, *Fl. Australia* 51: 409 (2006); isolecto: BM, FH; isolecto: BR, E *n.v.*, *fide* W.Schultze-Motel, *Willdenowia* 6: 90 (1970).

Illustrations: W.Schultze-Motel, *op. cit.* 90, fig. 10; 91, fig. 11; R.E.Magill, *Flora of Southern Africa. Bryophyta. Part 1: Mosses: Fascicle 1 Sphagnaceae–Grimmiaceae* 34, fig. 6, 13–21 (1981); R.D.Seppelt, *The Moss Flora of Macquarie Island* 57, fig. 23 (2004).

Stems 15–20 (–30) mm long. Leaves oblong, obovate, orbicular or lingulate, 0.7–2.0 mm wide, widest in mid-leaf or equally wide in base and mid-leaf, 1.5–2 times as long as wide; blade usually straight, rarely secund, not flexuose; apex variably flexed, broadly acute or obtuse, rounded or not, sometimes mucronate; sinus absent; margin usually partially broadly reflexed, entire; base distinctly sheathing; costa present, conspicuous only from mid-leaf to

base; laminal cells ±homogeneous, distally smooth or bulging, unistratose, proximally marginally isodiametric, not oblique. Perigonial paraphyses present. Perichaetial bracts not convolute, sheathing. Capsule base shorter than valves. Turgid spores 30–35 (–45) µm diam.; shrivelled spores 25–30 (–32) µm diam.

Occurs in N.S.W., A.C.T., Vic. and Tas.; also in New Zealand, Macquarie Is., Campbell Is., Auckland Is., Tristan da Cunha, South Georgia, New Guinea, southern Africa and western South America. Found in forested and subalpine landscapes, on moist to dripping, often deeply shaded outcrops and rocks (basalt, granite, rhyolite) at altitudes of 1050–2100 m. Map 20.

N.S.W.: Seamans Hut, [2 km ENE of Mt Kosciuszko], *H.Streimann 7674* (CANB, MO). A.C.T.: Mt Kelly, *H.Streimann 49128 p.p.* (CANB). Vic.: Mt Buffalo, *I.G.Stone 1146* (MEL); Mt Buller, along the S escarpment of "Baldy", *J.H.Willis 125* (WELT). Tas.: head of Meander R., *L.Rodway 2523* (HO, NSW).

An isolated taxon in the genus, *A. nitida* is rare and easily recognised by its large, usually oblong to ovate, occasionally almost orbicular, sometimes mucronate leaves and its weak, often fan-shaped and spurred costa that ends before or little distal to mid-leaf.

14. **Andreaea subulata** Harv., *in* W.J.Hooker, *Icon. Pl.* 3: 201 (1840)

T: "the Port", near Table Mtn, Cape of Good Hope, South Africa, 21 Mar. 1837, *W.H.Harvey*; BM, FH, NY, E *n.v.*, *fide* W.Schultze-Motel, *Willdenowia* 6: 78 (1970).

Andreaea subulata Harv. var. ß *rigida* Hook.f. & Wilson, *London J. Bot.* 3: 536 (1844). T: Hermite Is., Cape Horn [Chile], 1839–43, *J.D.Hooker*; syn: BM, FH, NY; Falkland Is., 1839–43, *J.D.Hooker*; syn: BM, FH, NY.

Andreaea pseudosubulata Müll.Hal., *Bot. Zeitung (Berlin)* 22: 373 (1864). T: Hermite Is., Cape Horn, [Chile], 1839–43, *J.D.Hooker*; *n.v.*; synonymy *fide* W.Schultze-Motel, *Willdenowia* 6: 77 (1970).

Andreaea subulatissima Müll.Hal., *Hedwigia* 37: 82 (1898). T: Recherche Bay, Tas., date unknown, *A.F.Oldfield s.n.*; BM, H, HO 74133, S.

Illustrations: R.E.Magill, *Flora of Southern Africa. Bryophyta. Part 1: Mosses: Fascicle 1 Sphagnaceae–Grimmiaceae* 34, fig. 6 (1981); R.D.Seppelt, *The Moss Flora of Macquarie Island* 59, fig. 24 (2004).

Stems 5–20 mm long. Leaves with blade tapering from an oblong base, 0.3–0.4 mm wide, widest in base, 3–5 times as long as wide; blade straight to falcate, secund or not, usually not flexuose; apex variably flexed, narrowly acute or acuminate, not rounded, not abruptly formed; sinus absent; margin incurved, entire; base distinctly sheathing; costa conspicuous from leaf apex to base, filling distal half of blade (or more); laminal cells ±homogeneous, distally smooth and bistratose or locally bistratose, proximally marginally mostly isodiametric, not oblique. Perigonial paraphyses present. Perichaetial bracts convolute and sheathing. Capsule base shorter than valves. Turgid spores 29–42 µm diam.; shrivelled spores 20–38 µm diam.

Occurs in N.S.W., Vic., Tas.; also in Macquarie Is., Auckland Is., Campbell Is., Falkland Is., Borneo, Madagascar, central and southern Africa and South America. Mainly found in forest and woodland dominated by *Eucalyptus* and *Nothofagus*, also grassland with heathy patches, often at the edge of watercourses; grows on rock (granite, sandstone and siltstone) at 300–1840 m. Map 22.

N.S.W.: Tinderry Peak [12 km E of Michelago], *H.Streimann 5197* (CANB); Weeping Rocks, *H.Streimann 47732* (CANB). Vic.: Mt Ellery, 29 Dec. 1951, *J.H.Willis s.n.* (MEL). Tas.: L. Perry, *W.A.Weymouth 2295* (CANB, HO, NY); Falls, Mt Wellington, *R.A.Bastow 338* (HO, MEL, NSW).

Andreaea subulata is one of the most widely distributed members of the genus, with a range similar to that of *A. amblyophylla*. Like the latter, it often occurs at lower elevations than other species (except *A. mutabilis*). It is characterised, as are *A. heinemannii* and *A. microvaginata*, by leaves with the blade tapering from the shoulder of an oblong base and a costa that reaches the apex and ±fills the blade. It is easily distinguished from *A. heinemannii* by its forest habitat, larger size, mostly isodiametric marginal cells in the leaf base and a capsule with the base shorter than the valves. *Andreaea subulata* and *A. heinemannii* are readily separated from *A. microvaginata* by their entire leaf margins and lack of a sinus.

15. Andreaea sp.

Stems 5–12 mm long. Leaves linear-lanceolate (only slightly panduriform), 0.25–0.30 mm wide, equally wide in base and mid-leaf, 3.5 times as long as wide; blade straight to slightly curved, not secund, not flexuose; apex cucullate or inflexed, broadly acute, rounded, not abruptly formed; sinus barely contracted; margin incurved, entire; base distinctly sheathing; costa absent; laminal cells heterogeneous, distally papillose and locally bistratose (in rather extensive patches and streaks that tend to be near margins proximally), proximally marginally isodiametric and rectangular, erect. Perigonial paraphyses present. Perichaetial bracts convolute and sheathing. Capsule base as long as valves. Turgid spores 18–30 (–37) µm diam.; shrivelled spores 16–30 µm diam.

Known from single localities in A.C.T. and Vic.; occurs in subalpine herbfield and *Eucalyptus* grassland; growing on semi-exposed surfaces of rock outcrops and under rock ledges. Map 21.

A.C.T.: Mt Gingera, *B.M.Murray 92-176* (ALA), *H.Streimann 3478* (CANB, H, NY). Vic.: Mt Buller, *H.Streimann 50714* (CANB).

The material cited appears to represent a new species, and its habit of growing upside down and well-shaded on the undersurfaces of rock ledges is striking and unusual. That and, especially, its locally bistratose leaves easily differentiate it from other Australian species with cucullate leaf apices (*A. amblyophylla* and *A. huttonii*). It is most closely related to the southern African species *A. bistratosa* Magill and the western South American species *A. peruviana* Broth., both of which have leaves that are more consistently bistratose. Study is underway to assess distinctness of the Australian material as well as unnamed western North American material that may be conspecific.

Doubtful and Excluded Names

Andreaea eximia Müll.Hal., *Hedwigia* 37: 84 (1898)

T: Mt Wellington, Tas., Jan. 1888, *W.A.Weymouth*; H-BR, HO.

Specimens of original material contain several taxa, the two main ones being *A. flexuosa* and *A. mutabilis*. The original description and diagnosis are too general for an unambiguous assignment of the name to either *A. flexuosa* or *A. mutabilis*. At present *A. eximia* is a candidate for *nomen confusum* status. However, study of pertinent correspondence and handwriting may help to determine if lectotypification is possible.

Andreaea rupestris Hedw., *Sp. Musc. Frond.* 47, t. 7, fig. 2g–o (1801)

T: Sweden, Britain, Bructeri, Saxony: Bielberg Annaemontani(?); lecto: G-Hedw. *n.v.*, *fide* D.H.Vitt, *New Zealand J. Bot.* 18: 368 (1980).

The name *A. rupestris* has been used in Australian literature and in herbaria as a catch-all for ecostate species of *Andreaea*. Vitt (1980) has suggested that *A. rupestris* is not present in the Southern Hemisphere, and this seems likely. Several small or depauperate specimens have characters similar to *A. rupestris*, but they probably represent immature *A. amblyophylla* or some other species. Therefore, at least for the present, *A. rupestris* is excluded from the Australian flora.

POLYTRICHACEAE

Jaakko Hyvönen[1]
[*Dawsonia* by *Bernard O. van Zanten*]

Polytrichaceae Schwägr., *in* C.L. von Willdenow, *Sp. Pl.* 5(2): 1 (1830).

Type: *Polytrichum* Hedw.

Dioicous or monoicous. Stems erect, rigid, simple or branched, with a polytrichoid (solid hydrome cylinder) or dawsonioid (hydroids and sclerenchyma) central strand. Rhizoids hyaline. Lower leaves small, often scale-like, appressed, remote; upper leaves larger, often crowded, with a broad pale unistratose sheathing base and a narrow lamina that is often bi- to multistratose almost to the margin. Lamina with isodiametric ±smooth abaxial cells; cuticle sometimes longitudinally striate; margin mostly entire to distinctly serrate, sometimes with specialised elongated marginal cells; sheath cells mostly rectangular to linear, narrower towards margin; costa single, prominent, percurrent to slightly excurrent, usually broad and ill-defined in lamina; lamellae on adaxial side of costa and lamina. Perichaetium terminal; perichaetial leaves scarcely differentiated, usually with a longer sheathing base. Perigonium rosulate, generally producing an annual innovation from the centre, with uni- to multiseriate paraphyses among antheridia; perigonial leaves with a wide-sheathing base and a rudimentary lamina. Calyptra small or large, mitrate or cucullate, rarely glabrous or apically serrate, often densely hairy. Setae terminal or pseudolateral by subperichaetial innovation, elongate, mostly single, smooth. Capsules erect, becoming slightly inclined to horizontal, symmetrical or asymmetrical, terete and cylindrical or angled; neck short and weakly differentiated or hemispherical, sometimes abruptly constricted from the urn as a hypophysis; stomata lacking or only on basal part of capsule; annulus absent or a single row of cells; operculum acute or rostellate. Peristome single; teeth 16–64, short, lingulate or triangular, curved inwards, attached at or near the rounded tips to a discoid expansion of the columella apex (epiphragm; lacking in *Dawsonia*), with a low or high basal membrane; in *Dawsonia* elongated with a bristle-like upper part. Peristome teeth consisting of whole elongated cells following the tooth shape in several concurrent rows, mostly pale except for a coloured midline. Spores globose, isomorphic, echinate, granulose or smooth (in *Dawsonia*).

The Polytrichaceae comprises 19 genera and c. 150–200 species. The family is widely distributed throughout the world, and diversity is highest in SE Asia and South America. Represented in Australia (except for W.A. and N.T.) by seven genera and 14 species; two are endemic. Plants grow in tufts, scattered or gregarious, on soil, humus or peat, rarely on rock. The family is an important component of the pioneer plant communities of disturbed soil, and many of the species are light-tolerant and xerophytic. Chromosome numbers are based on $x = 7$, with most Australian representatives having $n = 7$ chromosomes. Polyploidy to $n = 14$ is known in one taxon in Australia, *fide* H.P.Ramsay, *J. Hattori Bot. Lab.* 82: 213–226 (1997).

The genus *Dawsonia* was formerly segregated in the monotypic Dawsoniaceae, but it was transferred to the Polytrichaceae by Smith (1971). Some authors (Zanten, 1973; Beever *et al.*, 1992; Streimann & Klazenga, 2002) agree with this move, while others (Scott & Stone, 1976; Catcheside, 1980; Walther, 1983; Jarman & Fuhrer, 1995; Ramsay, 1997) maintain the Dawsoniaceae as a separate family.

G.L.Smith, A conspectus of the genera of Polytrichaceae, *Mem. New York Bot. Gard.* 21: 1–83 (1971); B.O. van Zanten, A taxonomic revision of the genus *Dawsonia* R.Brown, *Lindbergia* 2: 1–48 (1973); G.A.M.Scott & I.G.Stone, *The Mosses of Southern Australia* 79–80 (1976); D.G.Catcheside, *Mosses of South Australia* 47, 65 (1980); K.Walther, *A.Engler's Syllabus der Pflanzenfamilien, V, 2, Bryophytina, Laubmoose* 27 (1983); J.Beever, K.W.Allison & J.Child, *The Mosses of New Zealand*, 2nd edn 21–22 (1992); S.J.Jarman & B.A.Fuhrer,

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Mosses and Liverworts of Rainforest in Tasmania and South-eastern Australia 31, 52, 119 (1995); H.P.Ramsay, Cytotaxonomic studies on some Polytrichales from Australia, New Zealand, Papua New Guinea and Vanuatu, *J. Hattori Bot. Lab.* 82: 213–226 (1997); J.Hyvönen *et al.*, On phylogeny of the Polytrichales, *Bryologist* 101: 489–504 (1998).

KEY TO SPECIES

This key is based on gametophytic characters to facilitate the identification of all specimens: sporophyte attributes, although they are characteristic for genera, are ignored in this context. Consequently, a key is provided only for species because gametophyte characters are usually not diagnostic for individual genera.

Atrichum can be distinguished from other genera by lacking or having only sparse lamellae on the adaxial side of the narrow costa and by its narrow, slightly curved capsules with long, membranous calyptrae; *Notholigotrichum* by the triangular shape of the peristome teeth; *Pogonatum* by the deep reddish brown pigmentation of the peristome; *Polytrichastrum* by the cylindrical, terete to faintly plicate capsules with stomata on the basal hypophysis; *Polytrichum* by its leaves having a sheathing base and a narrow, lanceolate limb and box-like capsules with four distinct angles; *Polytrichadelphus* by the calyptra which is glabrous except for a few terminal erect bristles, the long-beaked operculum, and the asymmetrical, concave-convex capsule that is almost crescent-shaped in transverse section; and *Dawsonia* by its concave-convex capsules and bristle-like peristome.

1 Adaxial lamellae absent or fewer than 5, restricted to the costa .... **Atrichum androgynum**

1: Adaxial lamellae numerous, more than 25, covering almost the entire lamina 2

2 Apical cells of adaxial lamellae with distinct papillae *(1:)* 3

2: Apical cells of adaxial lamellae ±smooth or very slightly papillose to granulose 4

3 Plants small; stems less than 2 cm tall; leaves short, with a triangular lamina and entire or slightly denticulate margins *(2)* .... **Notoligotrichum australe**

3: Plants rather large; stems often more than 2 cm tall; leaves rather long, with a linear-lanceolate lamina and distinctly serrate margins .... **Polytrichastrum alpinum**

4 Margin of lamina widened, partly covering the adaxial lamellae *(2:)* ....**Polytrichum juniperinum**

4: Margin of lamina upcurved or flat, never covering the adaxial lamellae 5

5 Apical cells of at least the central adaxial lamellae retuse (cross-section) *(4:)* 6

5: Apical cells of the adaxial lamellae rounded or bottle-shaped 7

6 Lamellae distinctly crenate by the upper margin (side view); leaf margin serrate with multicellular teeth; lamina erect-spreading to slightly squarrose when moist *(5)* .... **Pogonatum neesii**

6: Lamellae straight or only slightly crenate by the upper margin (side view); leaf margin serrate with unicellular teeth; lamina distinctly squarrose when moist .... **Polytrichum commune**

7 Lamellae very irregularly crenate by the upper margin (side view) *(5:)* ....**Pogonatum tubulosum**

7: Lamellae regularly crenate or straight 8

8 Apical cells of adaxial lamellae with a distinctly thickened outer wall *(7:)* 9

8: Apical cells of adaxial lamellae with an outer wall as thin as other walls or only slightly thicker ... 10

9 Adaxial lamellae 4–5 (–6) cells high; dorsal laminal cells short-rectangular (1.4–2.5: 1) *(8)* ....**Dawsonia longiseta**

9: Adaxial lamellae 5–9 cells high; dorsal laminal cells (sub)quadrate ... **Polytrichadelphus magellanicus**

10 Stems with a dawsonioid central strand (hydroids and sclerenchyma) *(8:)* ....**Dawsonia superba** var. **pulchra**

10: Stems with a polytrichoid central strand (solid hydrome cylinder) 11

11 Adaxial lamellae ±straight to evenly rounded-crenate by the upper margin (side view) *(10:)* 12

11: Adaxial lamellae unevenly (obliquely) crenate by the upper margin (side view) 13

12 Unistratose leaf margin 5–13 cells wide, entire or only slightly denticulate apically; adaxial lamellae crenate by the upper margin (side view), with sparsely papillose apical cells *(11)*............................. ....**Notoligotrichum crispulum**

12: Unistratose leaf margin 2–6 cells wide, regularly serrate; adaxial lamellae indistinctly crenate or straight by the upper margin (side view), with smooth apical cells .... **Pogonatum subulatum**

13 Unistratose leaf margin 1 or 2 cells wide; leaves crowded, to 15 mm long *(11:)* .... **Dawsonia polytrichoides**

13: Unistratose leaf margin 3–10 cells wide; leaves rather remote, to 12 mm long....................................... .... **Polytrichastrum formosum**

1. ATRICHUM

Jaakko Hyvönen[1]

Atrichum P.Beauv., *Mag. Encycl.* 5: 329 (1804), *nom. cons*.; from the Greek *a-* (without) and *trichos* (a hair), in reference to the calyptra lacking the thick covering of hairs typical of many genera of Polytrichaceae.

Type: *A. undulatum* (Hedw.) P.Beauv.

Catharinea Ehrh. ex F.Weber & D.Mohr, *Index Mus. Pl. Crypt.* 2 (1803). T: *C. undulata* (Hedw.) F.Weber & D.Mohr [= *Atrichum undulatum* (Hedw.) P.Beauv.]

Dioicous or monoicous. Plants loosely caespitose, pale green to brown. Stems erect, unbranched. Rhizoids restricted to the stem base and the bases of the lowermost scale-like leaves. Leaves crisped when dry, erect-spreading when moist; lamina linear-lanceolate, gradually narrowing to a sharp apex, with ovate to subquadrate dorsal cells; margin serrate with duplicate teeth, bistratose, with differentiated elongated marginal cells; sheathing base poorly differentiated, the cells subquadrate to rectangular with firm walls, sometimes with cuticular papillae; costa percurrent to excurrent, apically sharply serrate with numerous abaxial teeth, these often also present in oblique rows on abaxial laminal surface; lamellae sparse or absent on adaxial surface of costa, to 5 cells high, ±straight or crenate by margin, with subquadrate to ovate cells. Calyptra apically smooth to rough, with a few short hairs. Setae solitary or several in each perichaetium. Capsules erect or slightly inclined, pale to dark brown; urn cylindrical, terete; exothecial cells subquadrate to elongate, with firm walls; stomata absent; operculum rostellate. Peristome with a low or high basal membrane; teeth 32, with a darker median part; epiphragm attached to apices of peristome teeth. Spores with a granulose surface.

A genus of c. 15–20 species predominantly in temperate regions of both hemispheres. Represented in Australia by one non-endemic species, *Atrichum* is a pioneer plant of open soil and, unlike most other genera of the family, it is not xerophytic but restricted to shady and moist habitats.

E.Nyholm, Studies in the genus *Atrichum* P.Beauv., *Lindbergia* 1: 1–33 (1971).

Atrichum androgynum (Müll.Hal.) A.Jaeger, *Ber. Tätigk. St. Gallischen Naturwiss. Ges.* 1873–74: 241 (1875)

Catharinea androgyna Müll.Hal., *Syn. Musc. Frond.* 1: 193 (1848). T: Swellendam, South Africa, *Ecklon*; *n.v.*

Catharinea muelleri Müll.Hal. & Hampe, *Linnaea* 26: 500 (1855); *Atrichum muelleri* (Müll.Hal. & Hampe) A.Jaeger, *Ber. Tätigk. St. Gallischen Naturwiss. Ges.* 1873–74: 243 (*Gen. Sp. Musc.* 1: 705) (1875), *nom. illeg.* (later homonym). T: Bunip [Bunyip] Ck and Dandenong Ra., Vic., Jan. 1853, *F.Mueller*; *n.v.*

Polytrichum ligulatum Mitt., *Hooker's J. Bot. Kew Gard. Misc.* 8: 262 (1859); *Atrichum ligulatum* (Mitt.) Mitt., *J. Proc. Linn. Soc.* 4: 97 (1860); *Catharinea ligulata* (Mitt.) Müll.Hal., *Genera Musc. Frond.* 165 (1900). T: Bornip [Bunyip] Ck, Vic., *F.Mueller 8*; syn: BM, MEL; *F.Mueller 12*; syn: BM; Tarwin, Vic., *F.Mueller 121*; syn: BM.

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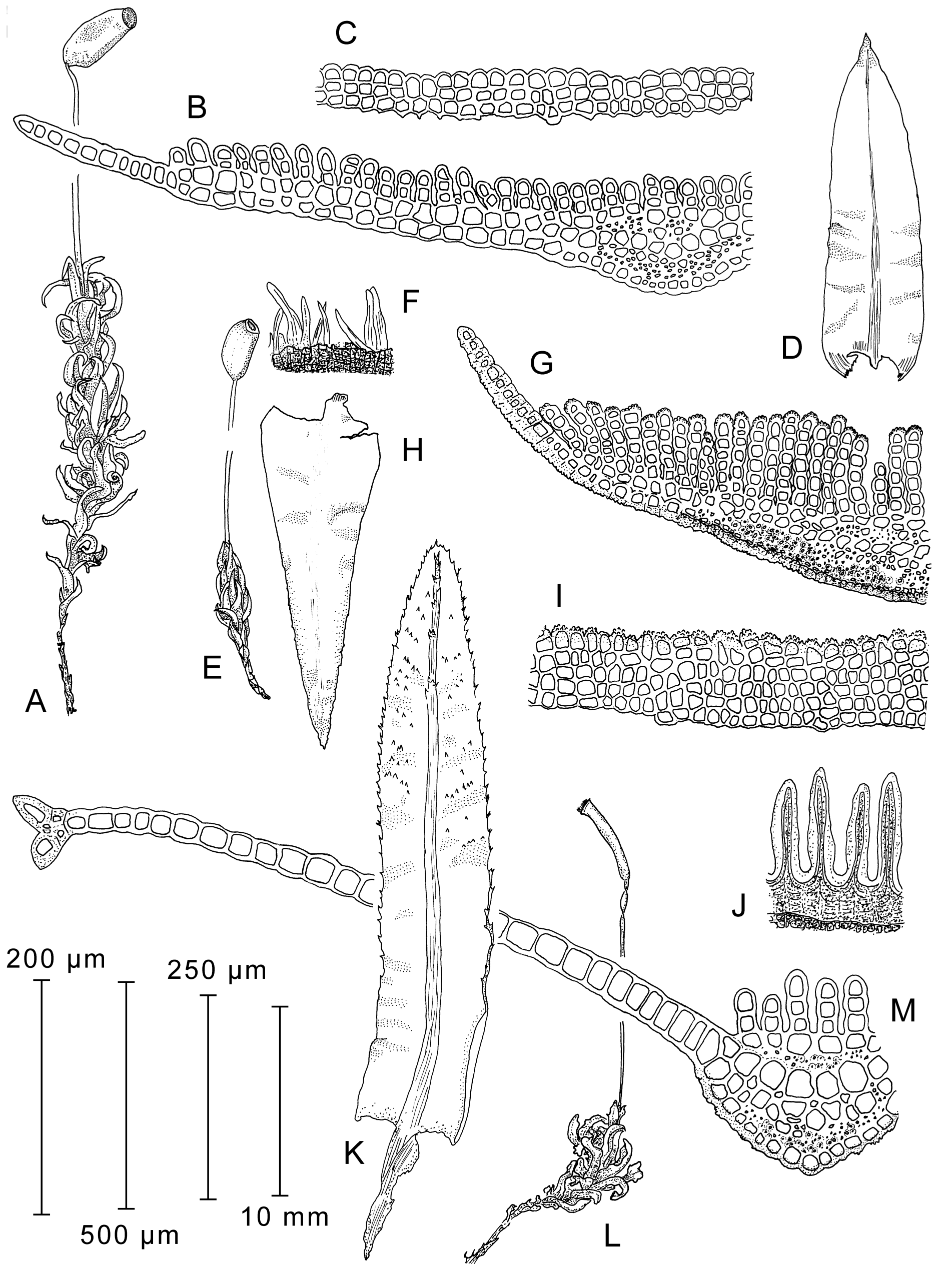

Figure 12. *Atrichum* and *Notoligotrichum*. **A–D**, *N. crispulum*. **A**, Habit (dry specimen); **B**, T.S. of mid-leaf; **C**, Lamella in side view; **D**, Leaf (*R.D.Seppelt 4478*, HO). **E–I**, *N. australe*. **E**, Habit (dry specimen); **F**, Peristome; **G**, T.S. of mid-leaf; **H**, Leaf; **I**, Lamella in side view (E–F and H–I, *A.Ratkowsky H374*, HO; G, *A.Moscal 24647*, HO). **J–M**, *A. androgynum*. **J**, Peristome; **K**, Leaf; **L**, Habit (dry specimen); **M**, T.S. of mid-leaf (J–M, *A.Moscal 20037*, HO). Use 200 µm scale for B, C, G, I and M; 500 µm scale for F and J; 250 µm scale for D, H and K; and 10 mm scale for A, E and L. Drawn by I.Ahonen.

Atrichum angustatum (Brid.) Bruch & Schimp. var. *polysetum* Wilson, *in* J.D.Hooker, *Fl. Tasman.* 2: 200 (1859); *Atrichum angustatum* (Brid.) Bruch & Schimp. var. *polysetum* Watts & Whitel., *Proc. Linn. Soc. New South Wales* 27 (Suppl.): 15 (1902), *nom. inval.* (basionym not cited). T: South Port Narrows, Tas., *A.F.Oldfield 66b*; syn: BM; Creek Town, Tas., *A.F.Oldfield 68*; syn: BM.

Catharinea minuta Müll.Hal., *Hedwigia* 36: 336 (1897); *Atrichum minutum* (Müll.Hal.) Paris, *Index Bryol.* Suppl. 1: 17 (1900); *Oligotrichum minutum* (Müll.Hal.) Paris, *Index Bryol.* Suppl. 1: 17 (1900). T: Mt Wellington, Tas., *D.Kayser*; *n.v.*

Catharinea sideroloma Müll.Hal., *Hedwigia* 36: 337 (1897); *Atrichum sideroloma* (Müll.Hal.) Paris, *Index Bryol.* Suppl. 1: 257 (1900). T: Moe R., Gippsland, Vic., 1881, *Luehmann*; *n.v.*

Catharinea pusilla Müll.Hal., *Hedwigia* 36: 338 (1897); *Atrichum pusillum* (Müll.Hal.) Paris, *Index Bryol.* Suppl. 1: 17 (1900). T: Marydale, Tas., 5 Dec. 1890, *W.A.Weymouth*; iso: H.

Catharinea leptocylindrica Müll.Hal., *Hedwigia* 36: 338 (1897); *Atrichum leptocylindricum* (Müll.Hal.) Paris, *Index Bryol.* Suppl. 1: 17 (1900). T: Fishen Bush, Oxford, North Canterbury, North Island, New Zealand, 1892, *T.W.Naylor Beckett*; syn: H; Genoa River, Vic., 1885, *W.Baeuerlen*; syn: Delegate, N.S.W., *W.Baeuerlen*.

Illustrations: E.Nyholm, *Lindbergia* 1: 27, fig. 15 (1971); G.A.M.Scott & I.G.Stone, *The Mosses of Southern Australia* 72, pl. 4 (1976); J.Beever, K.W.Allison & J.Child, *Mosses of New Zealand*, 2nd edn 24, fig. 9a–e; 56, pl. 4 (1992).

Stems to 6 cm tall. Leaves 5.7–9.5 mm long; lamina 0.9–1.5 mm wide, with teeth usually in oblique rows on abaxial surface; laminal cells of sheathing base sometimes with cuticular papillae; costa percurrent, with 3 or 4 lamellae on adaxial surface; lamellae ±straight or slightly crenate by upper margin, 2–5 cells high. Setae 1–5 in each perichaetium. Urn 3.2–7.4 mm long, 0.5–0.9 mm wide. Spores 11–17 µm diam. $n = 14$, *fide* H.P.Ramsay, *J. Hattori Bot. Lab.* 82: 215 (1997). Fig. 12J–M.

Occurs in N.S.W., A.C.T., Vic. and Tas.; also in New Zealand, Lord Howe Is., Central and South America and southern Africa. Grows on shaded soil in moist habitats. Map 23.

N.S.W.: Tallaganda State Forest, *H.Streimann 37840* (HO). A.C.T.: Cotter Valley, *N.T.Burbidge 6992* (CANB). Vic.: Kallista, *I.G.Stone 527* (MEL). Tas.: Marakoopa Cave State Reserve, *A.Moscal 24377* (HO); Fern Glade, *A.V.Ratkowsky* H98 (HO).

The species is readily distinguished from all other Australian Polytrichaceae by its long, narrow urn and leaves with only 3 or 4 low lamellae. Leaves are also typically crisped when dry.

2. DAWSONIA

Bernard O. van Zanten[1]

Dawsonia R.Br., *Trans. Linn. Soc. London* 10: 315 (1811); named after Dawson Turner (1775–1858), a distinguished cryptogamist and friend of Robert Brown.

Type: *D. polytrichoides* R.Br.

Dioicous; male gametoecia terminal, discoid, often repeatedly proliferating. Plants medium-sized to robust, to 25 cm tall, dark green. Stems erect or horizontally divergent from the substratum, simple, densely foliate, stiff. Rhizoids dense at base, whitish. Leaves usually appressed when dry, spreading when moist; sheath base usually with some longitudinal folds. Lamina lingulate or (narrowly) linear, with a broad ill-defined costa and a sharply serrate margin; dorsal cells rectangular, (1.4: 1–12.0: 1); shoulder cells 2- or 3-layered, forming well-differentiated swelling tissue; ventral surface of lamina with numerous rows of lamellae; lamella-free margin to 4 cells wide, the cells rectangular (1.2: 1–5.0: 1; outermost row 4: 1–8: 1), strongly and irregularly thickened on transverse walls. Calyptra cucullate, coriaceous, with a dense mat of entwining branched serrate hairs. Outer perichaetial leaves longer than stem leaves or not differentiated. Setae stiff, c. 2–4 cm long, brownish. Capsules

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erect, greenish when young, becoming inclined to horizontal, brownish or blackish when mature, ovoid, sharply 2-angled, flattened or concave dorsally, convex ventrally, with a small mouth; stomata at capsule base; columella strongly inflated, reticulate; epiphragm absent; operculum narrowly conical. Peristome consisting of numerous long filiform papillose teeth, connected at the base, inserted in several concentric rows, forming a slightly twisted white or dirty white brush-like tuft. Spores small, 5–14 µm diam., smooth, green. n = 7, *fide* H.P.Ramsay, *Bryologist* 67: 157 (1964).

Readily recognised in fruit by the distinctive peristome. Vegetatively some other taxa are very similar, but Dawsonia can always be recognised by the rectangular, dorsal laminal cells that are 1.4: 1–12.0: 1 compared with 1.0: 1–1.5: 1 in other local Polytrichaceae. The cells of the lamella-free lamina are also usually more elongated (1.2: 1–5.0: 1, and in outermost row 4: 1–8: 1, compared with 1.0: 1–1.5: 1 other species of Polytrichaceae) and more strongly thickened.

Dawsonia comprises two sections: sect. *Dawsonia* is distinguished by the central strand (hydrome) of the leafy part of the stem consisting of hydroids only; sect. *Superba* Schlieph. & Geh. emend. G.J.Sm. is characterised by this consisting of both hydroids and sclerenchyma. The former includes two taxa, *D. polytrichoides* and *D. longiseta*, both of which are endemic to Australia. The second section of seven species has its centre of diversity in New Guinea and extends into the eastern part of the Malesian region and the Solomon Is. This section includes mainly rainforest species, and it is represented in Australia by *D. superba* var. *pulchra*.

Dawsoniaceae was placed in the Polytrichaceae by Smith (1971) and van Zanten (1973) because of the significant similarities in vegetative characteristics, and this placement is maintained here.

A.Burges, The genus *Dawsonia*, *Proc. Linn. Soc. New South Wales*, ser. 2, 74: 83–96 (1949); R. van der Wijk, Revision of the genus *Dawsonia* R.Brown, *Rev. Bryol. Lichénol.*, n.s., 26: 8–19 (1957); B.O. van Zanten, A taxonomic revision of the genus *Dawsonia* R.Brown, *Lindbergia* 2: 1–48, pls II–XI (1973).

1. Dawsonia longiseta Hampe, *Linnaea* 28: 634 (1860)

T: Paramatta [Parramatta], N.S.W., *F.Mueller s.n.*; holo: BM.

Dawsonia longisetacea F.Muell., *Austral. Mosses* pl. 9 (1864), *nom. inval.* (orthogr. error).

Dawsonia appressa Hampe, *Linnaea* 28: 635 (1860). T: Onkaparinga, S.A., Mar. 1857, *F.Mueller s.n.*; holo: BM.

Dawsonia victoriae Müll.Hal., *Hedwigia* 36: 335 (1897). T: Doncaster, near Melbourne, Vic., 27 July 1884, *F.M.Reader s.n.*; iso: MEL.

Illustrations: B.O. van Zanten, *Lindbergia* 2: pls IIIh–k, VIIIa, Xd (1973); G.A.M.Scott & I.G.Stone, *The Mosses of Southern Australia* 77, pl. 6 (1976); D.G.Catcheside, *Mosses of South Australia* 66, fig. 10 (1980).

Stems 0.5–3.0 (–5.0) cm tall; hydrome cylinder of hydroids only. Leaves appressed when dry; sheath 1.5–2.5 mm long, c. 1.5 mm wide, somewhat abruptly or more gradually narrowed to the lamina, usually pale brownish to almost hyaline, the cells elongate-rectangular to linear, c. 60–100 × 8–12 µm. Lamina narrowly lingulate, often slightly contracted just above the leaf shoulder, (4–) 5–7 (–10) mm long, 0.6–1.0 mm wide, dorsally dentate near the acute ±boat-shaped apex; margin in upper 75% of leaf narrowly inflexed, sharply serrate (largest teeth cells to c. 100 µm long); dorsal laminal cells c. 15–35 × 12–15 µm (1.4: 1–2.5: 1), lateral and cross walls moderately incrassate; lamella-free lamina 2–4 cells wide, with short 14–20 × 8–10 µm cells, those of outermost row 2–4 times as long as wide with strongly incrassate walls. Lamellae 4–5 (–6) cells high, the apical cells symmetrically convex (side view), usually with strongly thickened outer walls, granulose, the lower lamellar cells usually quadrate or hexagonal. Outer perichaetial leaves not differentiated. Calyptra 8–15 mm long, not or somewhat (rarely strongly) barbed, only covering capsule, with yellowish brown to rusty brown hairs. Setae 2–4 cm long. Capsules 3–5 mm long. Spores 8–12 (–14) µm diam.

Endemic to south-eastern S.A., eastern Qld, N.S.W., A.C.T. and Vic. Grows mainly on clay, sandy or rocky soil on river banks, road cuttings, gullies, etc. in shady situations, often in dry- or wet-sclerophyll forest from sea level to c. 1000 m. Map 24.

S.A.: Cleland Wildlife Reserve, Mt Lofty Ra., *R.D.Seppelt 52168* (HO). Qld: Upper Coomera R., McPherson Ra., *H.Streimann 329* (CANB). N.S.W.: Lapstone Stone Hill, *W.Forsyth 1150* (GRO, H, JE, NSW, NY). A.C.T.: Black Mtn, *B.Hain 36* (AD, BRI, CANB, GRO, NY). Vic.: Upper Sealers Ck, Wilsons Promontory, *D.McVean 26569* (CANB).

Some sterile collections can be confused with *Polytrichum juniperinum*, but the latter is distinguished by its entire, membranaceous and strongly inflexed leaf margin. On rare occasions, plants are vegetatively identical to *D. longiseta* but have the rusty brown, strongly barbed calyptra of *D. polytrichoides*. Capsules of these specimens contain mostly aborted spores, possibly indicating hybridisation between the two species. This moss can also be confused with *Pogonatum subulatum*, but the latter is less densely leafy, has shorter, blunt marginal teeth, isodiametrical marginal cells and much shorter sheath cells.

This species was also recorded from Tasmania by Burges (*op. cit.* 95) and van der Wijk (*op. cit.* 14), but there are no herbarium specimens available for confirmation. Its occurrence in Tasmania is, therefore, doubtful.

2. **Dawsonia polytrichoides** R.Br., *Trans. Linn. Soc. London* 10: 316 (1811)

Triplocoma polytrichoides (R.Br.) Bach.Pyl., *J. Bot. (Desvaux)*, sér. 2, 3(5): 7 (1814), *nom. illeg. gen. prior*, *fide* R. v.d. Wijk & W.D.Margadant, *Index Muscorum* 5: 160 (1969). T: near Port Jackson, N.S.W., 1801–03, *R.Brown* [incorrectly labelled '*Chamisso*'?]; holo: BM.

Dawsonia polytrichoides var. *minor* Müll.Hal. ex Burges, *Proc. Linn. Soc. New South Wales*, ser. 2, 74: 92 (1949), *nom. inval*. T: Kangaroo Valley, N.S.W., Dec. 1885, *T.Whitelegge s.n.*; iso: GRO, H, JE, NSW.

Illustrations: A.Burgess, *Proc. Linn. Soc. New South Wales* 74: 88, fig. 8; 92, fig. 21 (1949); B.O. van Zanten, *Lindbergia* 2: pls IIIa–g, VIIIb, Xa (1973); G.A.M.Scott & I.G.Stone, *The Mosses of Southern Australia* 77, pl. 6 (1976).

Stems 3–10 (–20) cm tall; hydrome cylinder of hydroids only. Leaves appressed, rarely spreading when dry; sheath 1.5–2.5 mm long, 1.5–2.0 mm wide, rather abruptly narrowed to the lamina, brownish, the cells narrowly linear, 80–150 × 7–10 µm. Lamina linear, tapering to a fine usually sharply serrate point, (4–) 6–10 (–15) mm long, the upper leaves often longer, 0.5–0.8 mm wide, dorsally dentate to ±half-way down blade; margin sharply serrate (largest teeth cells to c. 150 µm long); dorsal laminal cells c. 50–80 × 8–10 µm (5: 1–10: 1), incrassate, especially the lateral walls; lamella-free lamina 1–3 cells wide, the cells firm-walled, 15–25 × 8–12 µm, those of outermost margin 3–5 times as long as wide and with strongly incrassate walls. Lamellae 4–5 (–6) cells high, the apical lamellar cells (side view) slightly longer to 1.5 times as long as high, asymmetrically convex (biggest bulge ±towards one end of cell) rendering lamellae serrulate; outer wall thin or firm, usually granulose, the lower lamellar cells quadrate-rectangular to hexagonal, often horizontally elongated. Outer perichaetial leaves not differentiated. Calyptra very large, 10–20 mm long, barbed, covering the entire capsule and usually the upper part of the seta, with long rusty brown hairs partly diverging from contracted calyptra base. Setae (15–) 20–30 mm long. Capsules (3–) 4–6 mm long. Spores 6–8 µm diam.

Endemic and common in eastern Qld and N.S.W., rarer in Vic. Grows on exposed or semi-shaded clay, sandy or rocky soil, often on river banks and road cuttings in dry- and wet-sclerophyll forest, from sea level to 1550 m. Map 25.

Qld: E of Atherton, Great Dividing Ra., *B.O. van Zanten 681273* (CANB, GRO, L); Kidner Rd, 9 km N of Ravenshoe, *H.Streimann 46643* (CANB). N.S.W.: Maxwells Rd, Nagee State Forest, 41 km SSW of Eden, *H.Streimann 38068* (CANB); 2 km E of Penrose, *D.Verdon 73/127* (CANB). Vic.: Bonang Hwy, 11 km SSW of Bonang, *H.Streimann 35466* (B, CANB, CHR, GRO, MICH, NY).

When fertile this species is always recognisable by its rusty brown, barbed calyptra. Vegetatively, while it is also quite distinctive, small plants can be confused with *D. longiseta* due to the small size and similar shape of the leaf blade. The difference in shape of the apical lamellar cells is not always conclusive because of the erosion of the outer wall of the apical

cells. In these rare cases, the rather abruptly narrowed sheath, the narrowly linear sheath cells and shorter dorsal laminal cells are diagnostic for *D. polytrichoides*.

This species can also be confused with *Polytrichum formosum*, *Polytrichastrum longisetum*, and with young plants of *Polytrichadelphus magellanicus* with simple stems. However, it can always be recognised by the rectangular, dorsal laminal cells and the elongate, strongly incrassate cells of the outermost row of marginal laminal cells.

This species was reported from Tasmania by Burges (*op. cit.* 93) and van der Wijk (*op. cit.* 14), but there are no herbarium specimens available for confirmation. Its occurrence in Tasmania is, therefore, doubtful.

3. **Dawsonia superba** Grev., *Ann. Mag. Nat. Hist.* 19: 226 (1847)

var. **pulchra** (Wijk) Zanten, *Jaarb. Kon. Ned. Bot. Ver.* 1971: 36 (1972)

Dawsonia pulchra Wijk, *Rev. Bryol. Lichénol.*, n.s., 26: 11 (1957). T: Mt Wilson, N.S.W., 25 Mar. 1952, *M.Tindale & E.F.Constable s.n.*; holo: NSW; iso: GRO, L.

Polytrichum longifolium Bruch & Schimp., *Bryol. Eur.* 4: 256 (1844); *Dawsonia longifolia* (Bruch & Schimp.) Zanten, *Lindbergia* 4: 133 (1977). T: "Neuholland" [Australia], *Von Huegel s.n.*; holo: W.

Dawsonia intermedia Müll.Hal. ex Schlieph. & Geh., *Rev. Bryol.* 23: 78 (1896); *D. superba* var. *intermedia* (Schlieph. & Geh.) Zanten, *Jaarb. Kon. Ned. Bot. Ver.* 1971: 36 (1972). T: Fernshaw, Upper Yarra R., Vic., Jan. 1881, *Luehmann s.n.*; holo: JE; iso: BM, H.

Illustrations: R. van der Wijk, *Rev. Bryol. Lichénol.*, n.s., 26: 10, fig. 3.1; 13, fig. 4.1 (1957); B.O. van Zanten, *Lindbergia* 2: pls IVb, e, f, IXa, Xf (1973); G.A.M.Scott & I.G.Stone, *The Mosses of Southern Australia* 77, pl. 6 (1976), as *D. superba*.

Stems 6–25 cm tall; leafy part to 15 cm tall; hydrome cylinder of hydroids and sclerenchyma. Leaves sometimes slightly secund at stem tips, usually appressed when dry; sheath 2.5–3.0 mm long, 2.0–2.5 mm wide, ±abruptly narrowed to the lamina, the cells linear, 120–150 × 8–11 µm. Lamina narrowly linear, usually spirally twisted (to 2 turns), rarely almost straight, ending in sharply serrate arista 9–18 (–22) mm long and 0.75–1.00 mm wide, dorsally usually sharply serrate near apex; margin often inrolled, making the lamina channelled or tubular; dorsal laminal cells c. (50–) 80–100 (–120) × 8–12 µm, firm-walled, the lateral walls usually more strongly thickened than cross walls; lamella-free lamina 1–3 (–4) cells wide, the cells irregularly transversely rectangular, 20–30 × c. 8–12 µm, incrassate, those of the outermost row 30–50 × c. 8 µm, hyaline with incrassate walls. Lamellae with straight outer walls (side view), (4–) 5–8 (–9) cells high, the apical cells usually ±enlarged, thin-walled or equally thickened, smooth or finely granulose, the lower lamellar cells irregularly hexagonal, thin-walled. Perichaetial leaves often considerably longer than stem leaves (to 30 mm). Calyptra not barbed, covering only the upper half of the capsule, pale brownish. Setae 10–35 mm long, smooth or minutely ribbed. Capsules 6–11 mm long, usually not or only slightly overtopping the perichaetial leaves. Spores 5–8 µm diam., green. Plates 3, 4.

Endemic to and widespread in eastern Qld, N.S.W., Vic. and Tas.; doubtfully recorded from Malesia. Grows in shady places on dry or damp earth-banks on heavy soils, road-cuttings in wet-sclerophyll forest, at c. 400–1500 m; in Tas. from sea level to c. 200 m. Map 26.

Qld: Kroombit Tableland, Port Curtis District, *I.R.Telford 5801* (CANB, GRO). N.S.W.: Zig Zag Rd, Mt Wilson, 21 km NNE of Katoomba, *H.Streimann 31695* (B, CANB, GRO, NICH, NY); Pinkwood Forest Reserve, 25 km SW of Moruya, *H.Streimann 15838* (ALTA, CANB, GRO, NICH, NY). Vic.: Sealers Cove, Wilsons Promontory, Aug. 1854, *F.Mueller* (BM, GRO, MEL). Tas.: Castra Rd, Ulverstone, *W.A.Weymouth 854* (BM, GRO, H, JE, S).

This species is much taller and has longer leaves than the other Australian species of *Dawsonia*. Small specimens, however, are similar in size to *D. polytrichoides*, but can be distinguished by the peculiar central strand, being a composite of hydroids and sclerenchyma. The straight outer walls of the lamellae (side view) are also distinctive. *Dawsonia superba* var. *superba* is the only *Dawsonia* occurring in New Zealand. It differs from var. *pulchra* in its taller stems (to 65 cm), more strongly twisted and longer leaf blades (to 30 mm), the decurrent swelling tissue, lower lamellae [4–5 (–6) cells high], shorter perichaetial leaves, and the setae that are minutely papillose in the upper part.

3. NOTOLIGOTRICHUM

Jaakko Hyvönen[1]

Notoligotrichum G.L.Sm., *Mem. New York Bot. Gard.* 21(3): 50 (1971); from the Greek *nothos* (false), *oligos* (few) and *trichos* (a hair), originally in reference to the sparsely hairy calyptra, here indicating resemblance to the genus *Oligotrichum* DC.

Type: *N. australe* (Hook.f. & Wilson) G.L.Sm.

Dioicous. Plants in cushions or loosely caespitose, olivaceous to brown. Stems usually simple, very rarely branched. Rhizoids restricted to the stem base. Leaves contorted or incurved when dry, erect-spreading to slightly recurved when moist; lamina triangular or linear-lanceolate, shorter or only slightly longer than the sheathing base, gradually narrowing to an acute often cucullate apex; abaxial cells with incrassate walls; margin denticulate or entire, flat or upcurved, unistratose; sheathing base ovate, gradually narrowing (without shoulders) to blade; cells with firm walls; costa percurrent to slightly excurrent, reddish brown, with a few abaxial teeth at apex; lamellae adaxial, almost completely covering the lamina, with subquadrate to ovate cells having incrassate to firm walls. Perigonia terminal. Calyptra apically smooth to rough, with a few short hairs. Setae usually solitary. Capsules inclined, pale to dark brown; urn slightly gibbous dorsally, constricted at mouth; exothecial cells subquadrate to elongate, with firm walls; stomata present on basal part; operculum rostellate. Peristome teeth 16 or 32, elongate-triangular, hyaline. Spores with a granulose surface.

A Southern Hemisphere genus of about ten species. Represented in Australia by two non-endemic species, *Notoligotrichum* is a pioneer plant of open soil in rather mesic habitats.

1. Notoligotrichum australe (Hook.f. & Wilson) G.L.Sm., *Mem. New York Bot. Gard.* 21(3): 51 (1971)

Polytrichum australe Hook.f. & Wilson, *in* J.D.Hooker, *Fl. Nov.-Zel.* 2: 87, fig. 6, 95 ('1855') [1854]; *Psilopilum australe* (Hook.f. & Wilson) Mitt., *J. Proc. Linn. Soc., Bot.* 4: 97 (1860). T: Ruahine Mtns, North Island, New Zealand, *W.Colenso*; *n.v.*

Illustrations: J.Hyvönen, *Acta. Bot. Fenn.* 133: 139, fig. 18 (1986); J.Beever, K.W.Allison & J.Child, *Mosses of New Zealand*, 2nd edn 27, fig. 12c (1992), as *Psilopilum australe*; R.D.Seppelt, *The Moss Flora of Macquarie Island* 220, fig. 87 (2004).

Stems to 18 mm tall. Leaves incurved when dry, erect-spreading to slightly incurved when moist, 2.8–5.4 mm long; lamina triangular, 0.4–0.8 mm wide; margin entire or slightly denticulate, flat, unistratose, 4–9 cells wide; sheathing base distinctly widened; costa percurrent to slightly excurrent; lamellae 30–48, crenate and coarsely papillose by upper margin, 5–8 cells high. Setae 1 (rarely 2) in each perichaetium. Urn 2.4–4.9 mm long, 1.6–2.7 mm wide. Peristome teeth 16. Spores 14–30 µm diam. $n = 7$, *fide* H.P.Ramsay, *J. Hattori Bot. Lab.* 82: 215 (1997). Fig. 12E–I.

Occurs in N.S.W., Vic. and Tas.; also in New Guinea, New Zealand, Macquarie Is., Heard Is. and southern Africa. A species of exposed habitats, usually confined to heaths above the tree-line. Map 27.

N.S.W.: Mt Kosciuszko, *I.G.Stone 11263* (MEL). Vic.: Mt Bogong, Feb. 1923, *A.J.Tadgell* (MEL). Tas.: Mt Wellington, *A.V.Ratkowsky B336* (MEL); Mt Barrow State Reserve, *A.Moscal 24586* (HO); Collins Bonnet, *A.V.Ratkowsky H376* (HO).

Notoligotrichum australe is distinguished from *N. crispulum* by its short-stemmed, stout habit and erect-spreading to incurved leaves. Sainsbury (*Bull. Roy. Soc. New Zealand* 5: 37, 1955) listed the hyaline leaf margins as a diagnostic character, but they are not present in all

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specimens. The leaf lamina is also typically triangular, whereas in *N. crispulum* it is lanceolate.

2. Notoligotrichum crispulum (Hook.f. & Wilson) G.L.Sm., *Mem. New York Bot. Gard.* 21(3): 51 (1971)

Polytrichum crispulum Hook.f. & Wilson, *in* J.D.Hooker, *Fl. Nov.-Zel.* 2: 87, fig. 3, 95 (‘1855’) [1854]; *Psilopilum crispulum* (Hook.f. & Wilson) Mitt., *J. Proc. Linn. Soc., Bot.* 4: 97 (1860); *Catharinea crispula* (Hook.f. & Wilson) Hampe, *Linnaea* 37: 517 (1872). T: Huiarau, North Island, New Zealand, *W.Colenso*; *n.v.*

Catharinea pyriformis Hampe, *Linnaea* 37: 517 (1872); *Atrichum pyriforme* (Hampe) A.Jaeger, *Ber. Tätigk. St. Gallischen Naturwiss. Ges.* 1873–74: 244 (1875); *Psilopilum pyriforme* (Hampe) A.Jaeger, *Ber. Tätigk. St. Gallischen Naturwiss. Ges.* 1877–78: 452 (1879). T: Blue Mtns, N.S.W., *F.Mueller*; iso: BM, MEL.

Illustrations: G.O.K.Sainsbury, *Bull. Roy. Soc. New Zealand* 5: 38, pl. 4, fig. 2 (1955); J.Beever, K.W.Allison & J.Child, *Mosses of New Zealand*, 2nd edn 27, fig. 12d (1992), as *Psilopilum crispulum*.

Stems to 45 mm tall. Leaves contorted or incurved when dry, erect-spreading to slightly recurved when moist, 4.1–7.6 mm long; lamina broadly lanceolate, 1.0–1.6 mm wide; margin denticulate apically, flat, unistratose, 5–13 cells wide; sheathing base very slightly widened; costa percurrent; lamellae 42–68, on adaxial surface of lamina, straight to regularly crenate and sparsely papillose by upper margin, 1–4 cells high, with rounded or bottle-shaped apical cells; outer wall the same thickness or slightly thicker than other walls. Urn 3.7–5.8 mm long, 2.0–3.4 mm wide. Peristome teeth 32. Spores 20–23 µm diam. Fig. 12A–D, Plate 6.

Occurs in N.S.W., Vic. and Tas.; also in New Zealand. Grows on soil in rather shaded habitats. Map 28.

N.S.W.: Blue Mtns, *F.Mueller* (MEL). Vic.: Falls Creek, *R.D.Seppelt 4478* (HO); Bogong High Plains, *I.G.Stone 9410* (MEL). Tas.: Wanderer R., *A.M.Buchanan 6251* (HO); Cradle Mtn, *A.V.Ratkowsky H379* (HO).

As indicated by the specific epithet, the contorted, rather distant leaves are a distinctive feature of this moss. Small specimens of *N. crispulum* can be difficult to identify when dry, but when moistened, the lanceolate shape of the lamina is readily seen. The sheathing base is about the same width as the lamina, and the lower lamellae, with their sparsely papillose apical cells, are also diagnostic.

4. POGONATUM

Jaakko Hyvönen[1]

Pogonatum P.Beauv., *Mag. Encycl.* 5: 329 (1804); from the Greek *pogon* (a beard), in reference to the hairy calyptra.

Type: *P. aloides* (Hedw.) P.Beauv.

Dioicous. Plants loosely caespitose, whitish green to brown. Stems erect, simple, rarely branched. Rhizoids restricted to stem base and bases of lowermost scale-like leaves. Leaves contorted to incurved when dry, erect-spreading to slightly squarrose when moist; lamina linear-lanceolate, gradually narrowing to a sharp apex, with dorsal cells ovate to subquadrate; margin serrate with multicellular teeth, flat to slightly upcurved, unistratose; sheathing base ovate, gradually narrowing or almost as wide as lamina, with subquadrate to rectangular cells with firm walls; costa percurrent to very slightly excurrent, reddish brown, apically sharply serrate with numerous dorsal teeth; lamellae covering almost the entire lamina. Calyptra hairy. Setae usually solitary. Capsules erect or slightly inclined, pale to dark brown; urn cylindrical, terete to faintly plicate; exothecial cells mammillose, subquadrate to elongate, with firm walls; stomata absent; operculum rostellate. Peristome

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teeth 32, compound, reddish brown; epiphragm attached to peristome teeth apices. Spores with a granulose surface.

A genus of c. 50 species in both hemispheres. Represented in Australia by three non-endemic species, *Pogonatum* is a pioneer plant of open, fine-grained soil.

J.Hyvönen, A synopsis of genus *Pogonatum* (Polytrichaceae, Musci), *Acta Bot. Fenn.* 138: 1–87 (1989).

1. **Pogonatum neesii** (Müll.Hal.) Dozy, *Bryol. Jav.* 1: 36, 40 (1856), *Ned. Kruidk. Arch.* 4(1): 75 (1856)

Polytrichum neesii Müll.Hal., *Syn. Musc. Frond.* 2: 563 (1851). T: Java, [Indonesia], *Blume*; holo: B *n.v.* (probably destroyed).

Polytrichum australasicum Müll.Hal. & Hampe, *Linnaea* 26: 500 (1855); *Pogonatum australasicum* (Müll.Hal. & Hampe) A.Jaeger, *Ber. Tätigk. St. Gallischen Naturwiss. Ges.* 1873–74: 256 (*Gen. Sp. Musc.* 1: 718) (1875). T: along the wood road over the Blackspur, Vic., *F.Mueller*; iso: BM.

Polytrichum brachypodium Müll.Hal., *Hedwigia* 36: 342 (1897); *Pogonatum brachypodium* (Müll.Hal.) Watts & Whitel., *Proc. Linn. Soc. New South Wales* 27 (Suppl.): 18 (1902). T: Fitzroy Falls, Moss Vale, N.S.W., Nov. 1884, *T.Whitelegge*; iso: H.

Polytrichum camarae Müll.Hal., *Hedwigia* 36: 341 (1897); *Pogonatum camarae* (Müll.Hal.) Paris, *Index Bryol.* 978 (1897); *Pogonatum baileyi* Broth ex Müll.Hal., *Hedwigia* 36: 342 (1897), *nom. inval.* (in synon.). T: Clarence R., N.S.W., Nov. 1875, *Wilcox*; syn: JE; White Cap Mtns, *De la Camara*; syn: H, JE.

Polytrichum gippslandiae Müll.Hal., *Hedwigia* 36: 341 (1897); *Pogonatum gippslandiae* (Müll.Hal.) Paris, *Index Bryol.* Suppl. 1: 278 (1900). T: Tyers R., Gippsland, Vic., 1881, *H.Tysdale*; iso: H.

Polytrichum nanocarpum Müll.Hal., *Hedwigia* 36: 340 (1897); *Pogonatum nanocarpum* (Müll.Hal.) Paris, *Index Bryol.* Suppl. 1: 278 (1900). T: Walhalla, Gippsland, Vic., 1884, *H.Tysdale*; *n.v.*

Illustrations: T.Osada, *J. Hattori Bot. Lab.* 28: 199, fig. 11 (1965), as *Pogonatum akitense*; J.Hyvönen, *Acta Bot. Fenn.* 133: 128, fig. 12 (1986); A.Noguchi, *Moss Flora Japan* 1: 41, fig. 13b (1987), as *Pogonatum akitense*.

Stems to 5.5 cm tall. Leaves incurved to contorted when dry, erect-spreading to slightly squarrose when moist, 3.7–7.9 mm long; lamina narrowly lanceolate, 0.5–1.0 mm wide; margin serrate with multicellular teeth, flat to upcurved, unistratose, 2–5 cells wide; sheathing base widened; costa percurrent to excurrent, with numerous abaxial teeth apically; lamellae 26–48, on adaxial surface of lamina, crenate by upper margin, 3–6 cells high, with apical cells retuse (in cross-section), smooth or very slightly papillose. Urn 3.5–6.1 mm long, 1.1–1.7 mm wide. Spores 7–11 µm diam. n = 7, *fide* H.P.Ramsay, *J. Hattori Bot. Lab.* 82: 217 (1997). Fig. 13A–D.

Occurs in Qld, N.S.W. and Vic.; also widely distributed in temperate and tropical Asia and the western Pacific; a plant of bare loamy soil and sand on stream banks and roadsides. Map 29.

Qld: Springbrook, *I.G.Stone 4956* (MEL); Binna Burra, *I.G.Stone 12961* (MEL). N.S.W.: Bourkes Ck, *H.Streimann 15317* (HO); Clyde Mtn, *R.Filson 10930* (MEL). Vic.: Yarra State Forest, *K.R.Thiele 6* (MEL).

Pogonatum neesii has adaxial lamellae with retuse apical cells which are distinctly crenate when seen in side view.

2. **Pogonatum subulatum** (Brid.) Brid., *Bryol. Univ.* 2: 122 (1827)

Polytrichum subulatum Brid., *J. Bot. (Schrader)* 1800(1): 287 (1801). T: New Zealand, *Nelson*; holo: E.

Polytrichum nanournigerum Müll.Hal., *Hedwigia* 36: 340 (1897); *Pogonatum nanournigerum* (Müll.Hal.) Paris, *Index Bryol.* Suppl. 1: 278 (1900). T: North Island, New Zealand, 1882, *F.M.Reader*, "misit 1892 ex Dimboola Victoriae"; *n.v.*

Illustrations: G.A.M.Scott & I.G.Stone, *The Mosses of Southern Australia* 75, pl. 5 (1976); J.Hyvönen, *Acta Bot. Fenn.* 138: 57, fig. 18 (1989); J.Beever, K.W.Allison & J.Child, *Mosses of New Zealand*, 2nd edn 27, fig. 12e (1992).

Stems to 4.5 cm tall. Leaves incurved to contorted when dry, recurved when moist, 3.6–6.5 mm long; lamina linear-lanceolate, 0.8–1.2 mm wide; margin regularly serrate, flat, unistratose, 2–6 cells wide; sheathing base slightly widened; costa percurrent to excurrent, with apical

abaxial teeth; lamellae 36–54 on adaxial surface of lamina, 2–4 cells high, straight to slightly crenate by upper margin, with apical cells rounded (in cross-section), the outer wall as thin as or only slightly thicker than other cell walls. Urn 3.2–4.5 mm long, 1.0–1.8 mm wide. Spores 7–11 µm diam. *n* = 7, *fide* H.P.Ramsay, *J. Hattori Bot. Lab.* 82: 219 (1997). Fig. 13G–J, Plates 5, 7.

Occurs in N.S.W., A.C.T., Vic. and Tas.; also in New Zealand. A plant of bare ground, especially on roadside banks. Map 30.

N.S.W.: Toomumbar State Forest, *R.Coveny 4435* (NSW). A.C.T. Brindabella Ra., *H.Streimann 5265* (H). Vic.: Dandenong Ra., *D.G.Catcheside 54.98* (CANB). Tas.: Mt Wellington, *A.V.Ratkowsky H342* (HO); Liffey Falls State Reserve, *A.Moscal 17653* (HO).

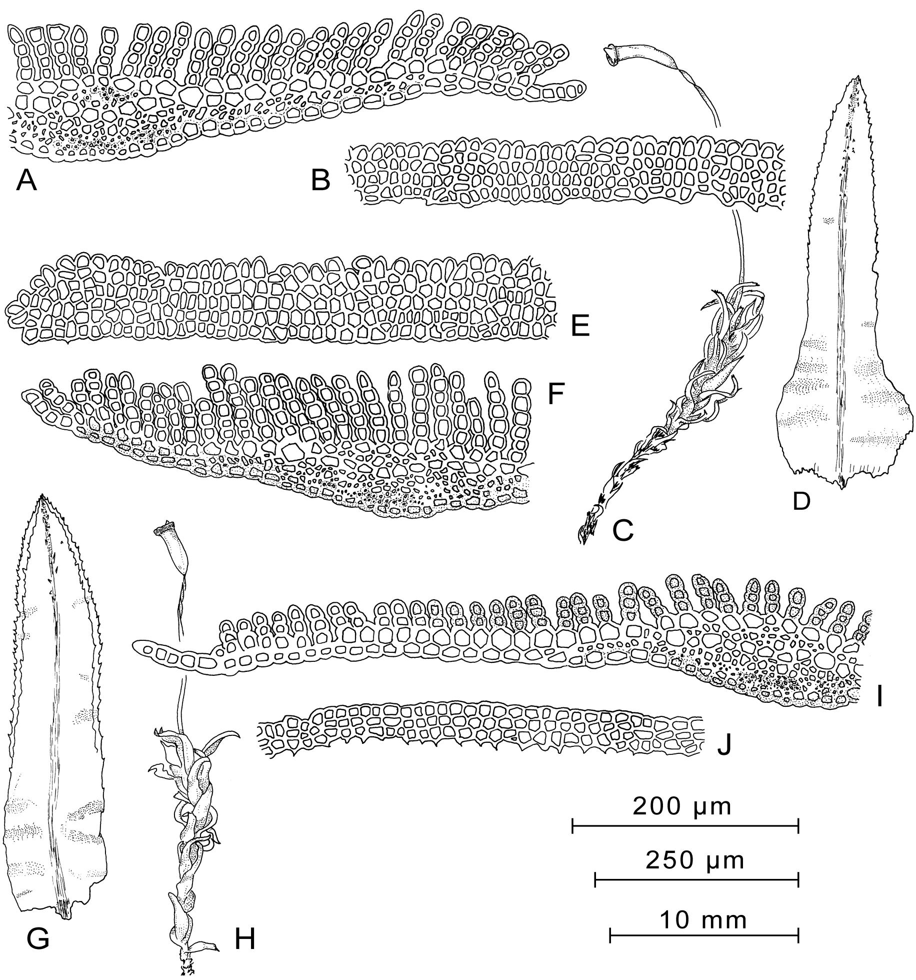

Figure 13. *Pogonatum*. **A–D**, *P. neesii*. **A**, T.S. of mid-leaf; **B**, Lamella in side view; **C**, Habit (dry specimen); **D**, Leaf (A–D, *R.Hoogland 8583*, CANB). **E–F**, *P. tubulosum*. **E**, Lamella in side view; **F**, T.S. of mid-leaf (E–F, *I.Stone 8571*, MEL). **G–J**, *P. subulatum*. **G**, Leaf; **H**, Habit (dry specimen); **I**, T.S. of mid-leaf; **J**, Lamella in side view (G–J, *A.Moscal 24411*, HO). Use 200 µm scale for A, B, E, F, I and J; 250 µm scale for D and G; and the 10 mm scale for C and H. Drawn by I.Ahonen.

Pogonatum subulatum is the most common of the three *Pogonatum* species in Australia. It is readily distinguished by the narrow sheath and rather remote adaxial lamellae.

3. **Pogonatum tubulosum** Dixon, *J. Bot.* 80: 34 (1942)

T: above Port Moresby, Uniri R., Central Province, [Papua] New Guinea, *Carr 15194*; holo: BM.

Illustrations: J.Hyvönen, *Acta Bot. Fenn.* 133: 126, fig. 11 (1986); J.Hyvönen, *Acta Bot. Fenn.* 138: 55, fig. 17 (1989).

Stems to 2.3 cm tall. Leaves incurved to contorted when dry, slightly recurved to erect-spreading when moist, 3.7–7.9 mm long; lamina narrowly lanceolate, 0.4–1.1 mm wide; margin serrate with multicellular teeth, flat or upcurved, unistratose, 3–5 cells wide; sheathing base widened; costa percurrent to excurrent, with apical abaxial teeth small or absent; lamellae 28–50, on adaxial surface of lamina, 4–6 cells high, irregularly crenate by the upper margin, with apical cells rounded to rarely retuse (in cross-section). Urn 3.2–4.1 mm long, 1.3–1.5 mm wide. Spores 10–13 µm diam. Fig. 13E–F.

Occurs in north-eastern Qld; also in New Guinea. This is a plant of loamy stream banks and roadsides. Map 31.

Qld: Main Coast Ra., 18 km NNW of Mt Molloy, *H.Streimann 30351* (CANB, L, NICH, NY); Mt Lewis, *B.O. van Zanten 681179* (CANB, L, MEL, NY); Mt Fisher, Atherton Tableland, *I.G.Stone 15730, 15736* (MEL); Palmerston Natl Park, *I.G.Stone 25113* (MEL); Lamins Hill, near Malanda, *G.H.Bell 641* (AD).

Only one of the six known Australian specimens includes sporophytes, and the description of these characters is based on comparatively few measurements. *Pogonatum tubulosum* is easily distinguished from other species by the irregularly crenate apical cells of the lamellae.

5. POLYTRICHADELPHUS

Jaakko Hyvönen[1]

Polytrichadelphus (Müll.Hal.) Mitt., *J. Proc. Linn. Soc., Bot.* 4: 97 (1860); from the Greek *poly* (many), *trichos* (a hair) and the Greek *adelphos* (a brother), in reference to the close relationship to the genus *Polytrichum*.

Type: *P. magellanicus* (Hedw.) Mitt.

Dioicous. Plants loosely caespitose, dark green to brown. Stems erect, simple (rarely branched). Rhizoids restricted to subterranean part of stem. Leaves appressed when dry, recurved when moist; lamina linear-lanceolate, gradually narrowing to an acute apex, with ovate to subquadrate dorsal cells; margin serrate with unicellular teeth, distinctly upcurved, unistratose; costa slightly excurrent, reddish brown, apically sharply serrate with abaxial teeth; sheathing base ovate, gradually or abruptly narrowing to lamina, with subquadrate to rectangular cells with firm walls; lamellae almost covering the lamina. Calyptra sparsely hairy. Setae usually solitary, terminal or pseudolateral by subperichaetial innovation. Capsules inclined, pale to dark brown; urn with 2 distinct angles (crescent-shaped in cross-section); exothecial cells subquadrate, with firm walls; stomata restricted to basal third of capsule; operculum rostellate. Peristome teeth 64, pale brown; epiphragm thin, attached to peristome teeth apices. Spores with a granulose surface.

A genus of about ten species in Australia, New Zealand, New Guinea, South America and Tristan da Cunha. Represented in Australia by one non-endemic species, *Polytrichadelphus* is a pioneer plant of soil in open habitats.

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Polytrichadelphus magellanicus (Hedw.) Mitt., *J. Proc. Linn. Soc., Bot.* 4: 97 (1860)

Polytrichum magellanicum Hedw., *Sp. Musc. Frond.* 101, pl. 20, figs 1, 2 (1801). T: Fretum Magellanicum, *P.Commerson*; lecto: PC *n.v.*

Catharinea arnoldii Hampe, *Linnaea* 38: 664 (1874); *Polytrichadelphus arnoldii* (Hampe) A.Jaeger, *Ber. Tätigk. St. Gallischen Naturwiss. Ges.* 1873–74: 246 (1875); *Oligotrichum arnoldii* (Hampe) Kindb., *Enum. Bryin. Exot.* 68 (1888). T: Mt Arnold, Australian Alps, *coll. unknown*; iso: H-BR.

Catharinea innovans Müll.Hal., *Bot. Zeitung (Berlin)* 9: 548 (1851); *Polytrichadelphus innovans* (Müll.Hal.) A.Jaeger, *Ber. Tätigk. St. Gallischen Naturwiss. Ges.* 1873–74: 245 (1875); *Oligotrichum innovans* (Müll.Hal.) Kindb., *Enum. Bryin. Exot.* 69 (1888). T: Mt Wellington, Tas., *S.Mossman 752*; iso: JE.

Catharinea australasica Hampe, *Linnaea* 40: 315 (1876); *Polytrichadelphus australasicus* (Hampe) A.Jaeger, *Ber. Tätigk. St. Gallischen Naturwiss. Ges.* 1877–78: 453 (1879); *Oligotrichum australasicum* (Hampe) Kindb., *Enum. Bryin. Exot.* 68 (1888). T: “subtropical eastern Australia”, *Eaves*; *n.v.*

Catharinea lagenacea Müll.Hal., *Hedwigia* 36: 338 (1897); *Polytrichadelphus lagenaceus* (Müll.Hal.) Paris, *Index Bryol.* Suppl. 1: 279 (1900). T: Marydale, Tas., 5 Dec. 1891, *W.A.Weymouth*; iso: H-BR.

Catharinea profilicans Müll.Hal., *Hedwigia* 36: 339 (1897); *Polytrichadelphus prolificans* (Müll.Hal.) Paris, *Index Bryol.* Suppl. 1: 279 (1900). T: Mt Wellington, Tas., *J. & B.Gullwer*; iso: H-BR.

Illustrations: G.O.K.Sainsbury, *Bull. Roy. Soc. New Zealand* 5: 32, pl. 2, fig. 1 (1955); J.Beever, K.W.Allison & J.Child, *Mosses of New Zealand*, 2nd edn 25, fig. 10a–h (1992); M.M.Schiavone, *Fl. Criptogámica de Tierra del Fuego* XIV (12): 19, pl. IV (1993).

Stems to 14.5 cm tall. Leaves appressed when dry, recurved when moist, 5.8–9.6 mm long; lamina 0.5–1.0 mm wide; abaxial cells with incrassate outer walls; margin flat to distinctly upcurved, unistratose, 2 or 3 cells wide; sheathing base rather abruptly widened; costa with apical abaxial teeth; lamellae 34–50, on adaxial surface of lamina, 5–9 cells high, distinctly crenate by upper margin, with apical cells pyriform (in cross-section) with a distinctly incrassate outer wall. Urn 4.1–6.8 mm long, 2.2–3.9 mm wide. Spores 10–15 µm diam. $n = 7$, *fide* H.P.Ramsay, *J. Hattori Bot. Lab.* 82: 221 (1997). Fig. 15I–M, Plates 8, 9.

Occurs in Vic. and Tas.; also in New Zealand and South America. This coloniser of open soil is often locally abundant. Map 32.

Vic.: Acheron Way, *H.Streimann 50814* (CANB, KRAM, MAHU, NY, TBA); Bogong High Plains, *I.G.Stone 9408* (MEL); Mt Donna Buang State Forest, *A.W.Thies FN1468H* (MEL). Tas.: Fern Glade, *D.A. & A.V.Ratkowsky B339* (MEL); Lachland Rd, *A.V.Ratkowsky H356* (HO).

Polytrichadelphus magellanicus is distinguished from other large species of Polytrichaceae by its capsules having two distinct angles giving them a crescent shape in cross-section. Plants occurring in Australia and New Zealand have been treated as a distinct species, *P. innovans*. However, I am inclined to treat all specimens from both sides of the Pacific Ocean as belonging to *P. magellanicus*.

6. POLYTRICHASTRUM

Jaakko Hyvönen[1]

Polytrichastrum G.L.Sm., *Mem. New York Bot. Gard.* 21(3): 35 (1971); from the Greek *poly* (many), *trichos* (a hair) and the Latin *-astrum* (indicating likeness or inferiority), in reference to the relationship to *Polytrichum*.

Type: *P. alpinum* (Hedw.) G.L.Sm.

Dioicous. Plants loosely caespitose, bright green to brown. Stems erect, simple or branched. Rhizoids restricted to stem base and bases of lowermost scale-like leaves. Leaves appressed, erect-spreading when dry, erect-spreading to distinctly recurved when moist; lamina linear-

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lanceolate, gradually narrowing to a sharp apex, with ovate to subquadrate abaxial cells; margin serrate with large teeth, distinctly upcurved to flat, unistratose; sheathing base ovate, abruptly or gradually narrowing to lamina, with subquadrate to rectangular cells with firm walls; costa slightly excurrent, reddish brown, apically sharply serrate with abaxial teeth; lamellae almost covering the lamina. Calyptra hairy. Setae usually solitary, terminal or pseudolateral by subperichaetial innovation, smooth. Capsules erect or slightly inclined, pale to dark brown; urn cylindrical, terete to faintly plicate; exothecial cells smooth, subquadrate to elongate, with firm walls; stomata restricted to basal hypophysis; operculum rostellate. Peristome teeth c. 64, pale brown; epiphragm thick. Spores with a granulose surface.

A genus of approximately 15 species in both hemispheres. Represented in Australia by two non-endemic species, *Polytrichastrum* is a pioneer plant of open soil and peat.

1. **Polytrichastrum alpinum** (Hedw.) G.L.Sm., *Mem. New York Bot. Gard.* 21(3): 37 (1971)

Polytrichum alpinum Hedw., *Sp. Musc. Frond.* 92 (1801); *Pogonatum alpinum* (Hedw.) Röhl., *Ann. Wetterauischen Ges. Gesammte Naturk.* 3(2): 226 (1814). T: Europe; *n.v.*

Polytrichum pseudoalpinum Müll.Hal., *Bot. Zeitung (Berlin)* 13: 750 (1855); *Pogonatum pseudoalpinum* (Müll.Hal.) A.Jaeger, *Ber. Tätigk. St. Gallischen Naturwiss. Ges.* 1873–74: 262 (1875). T: "Australia Felix, in subalpinis"; *n.v.*

Polytrichum austroalpinum F.Muell. ex Hampe, *Linnaea* 28: 211 (1856), *nom. inval.* (in synon.). T: "In monte Cobboras", [Vic.], *F.Mueller*; *n.v.*

Polytrichum austroalpinum Müll.Hal., *Bot. Jahrb. Syst.* 5: 77 (1883); *Pogonatum austroalpinum* (Müll.Hal.) Paris, *Index Bryol.* 971 (1898). T: Kerguelen Island, *F.C.Naumann*; *n.v.*

Polytrichum obliquirostre Müll.Hal., *Hedwigia* 36: 342 (1897). T: Mt William, Vic., Oct. 1878, *D.Sullivan*; iso: JE.

Illustrations: H.A.Crum & L.E.Anderson, *Mosses of Eastern North America* 2: 1267, fig. 629 (1981), as *Pogonatum alpinum*; D.G.Long, *Bioscience* 17: 28, fig. 8 (1985); J.Beever, K.W.Allison & J.Child, *Mosses of New Zealand*, 2nd edn 27, fig. 12f (1992).

Stems to 13 cm tall. Leaves appressed to erect-spreading when dry, recurved when moist, 4.8–11.0 mm long; lamina 0.4–0.8 mm wide, with abaxial cells having a distinctly incrassate outer wall; margin serrate, upcurved, unistratose, 3–6 cells wide; sheathing base rather abruptly widened; costa with apical abaxial teeth; lamellae 26–44, on adaxial surface of lamina, 5–8 (–9) cells high, ±straight by upper margin, with apical cells pyriform in cross-section and with an extremely incrassate and ±papillose outer wall. Urn terete, 3.7–5.9 mm long, 1.7–2.7 mm wide. Spores 13–23 µm diam. $n = 7$, *fide* H.P.Ramsay, *J. Hattori Bot. Lab.* 82: 219 (1997). Fig. 14D–G.

Occurs in N.S.W., A.C.T., Vic. and Tas.; also in the Antarctic, Subantarctic islands, New Zealand and South America; widespread in the temperate and boreal parts of the Northern Hemisphere. This is a plant of various open habitats, most commonly found near non-calcareous boulders and rocks. Map 33.

N.S.W.: Mt Kosciuszko, *H.Streimann 5313* (AD, H, L, MO, NICH). A.C.T.: Brindabella Ra., *D.Verdon 1014* (CANB, HO, L). Vic.: Bogong High Plains, *I.G.Stone 10614* (MEL); Langford Gap, *I.G.Stone 14347* (MEL). Tas.: Mt Field, *A.Moscal 23341* (HO).

Polytrichastrum alpinum is distinguished from all other large Australian Polytrichaceae by its terete capsules and the extremely incrassate and papillose outer wall of the apical cells of the adaxial lamellae.

2. **Polytrichastrum formosum** (Hedw.) G.L.Sm., *Mem. New York Bot. Gard.* 21(3): 37 (1971)

Polytrichum formosum Hedw., *Sp. Musc. Frond.* 92 (1801). T: Die Vogelsteine, Sudetes; *n.v.*

Illustrations: A.J.E.Smith, *Moss Flora of Britain and Ireland* 93, fig. 354 (1978); H.A.Crum & L.E.Anderson, *Mosses of Eastern North America* 2: 1273, fig. 632 (1981); J.Beever, K.W.Allison & J.Child, *Mosses of New Zealand*, 2nd edn 27, fig. 12a (1992).

Stems to 18 cm tall. Leaves appressed to erect-spreading when dry, distinctly recurved when moist, 6.0–12.3 mm long; lamina 0.7–1.2 mm wide, abaxial cells with distinctly incrassate outer walls; margin flat to upcurved, unistratose, 3–10 cells wide; sheathing base gradually widened; costa with apical abaxial teeth; lamellae 42–66, on adaxial surface of lamina, 3–7 cells high, ±straight to obliquely crenate by upper margin; apical cells rounded to very slightly pyriform in cross-section. Urn 4.5–6.2 mm long, 1.9–2.4 mm wide, with 4 rounded angles. Spores 15–20 µm diam. Fig. 14A–C.

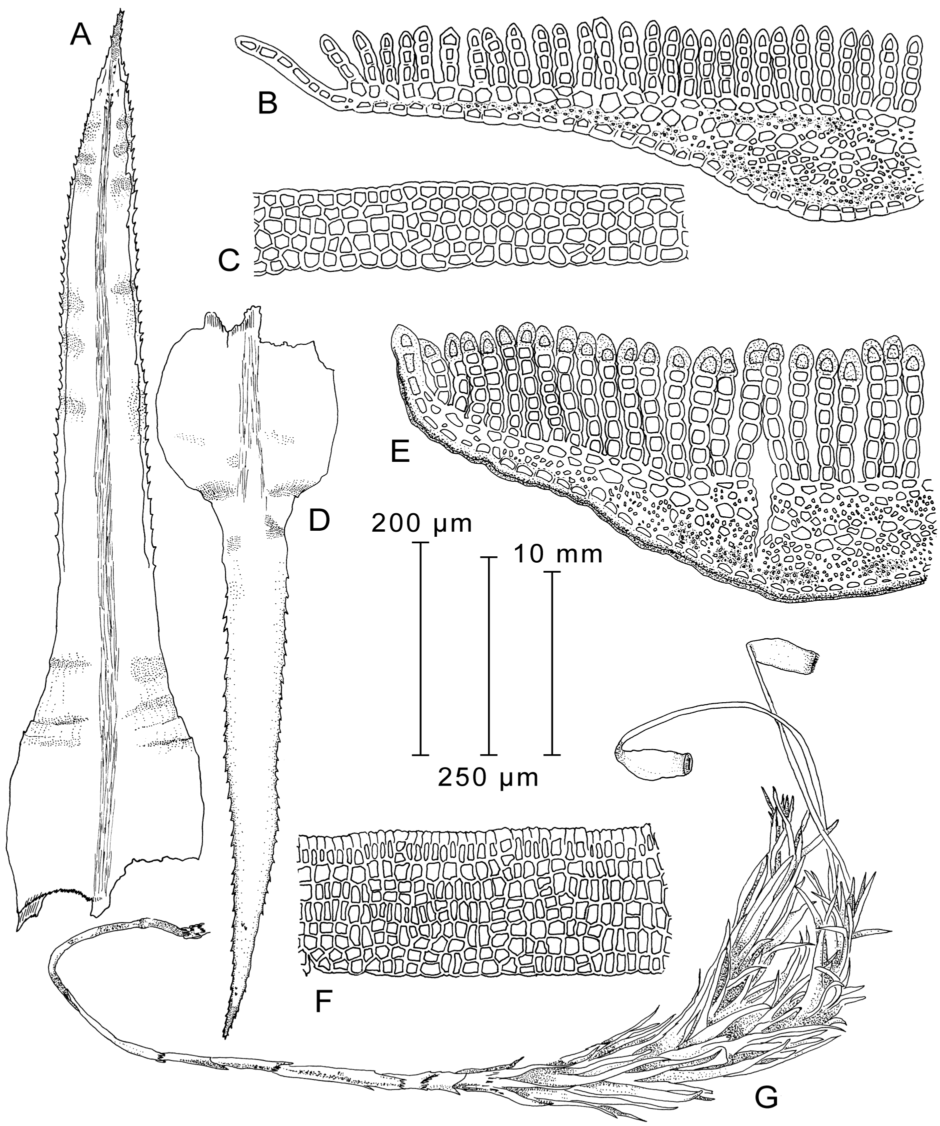

Figure 14. *Polytrichastrum*. **A–C**, *P. formosum*. **A**, Leaf; **B**, T.S. of mid-leaf; **C**, Lamella in side view (A–C, *L.Rodway*, Dec. 1917, HO). **D–G**. *P. alpinum*. **D**, Leaf; **E**, T.S. of mid-leaf; **F**, Lamella in side view; **G**, Habit (dry specimen) (D–G, *A.Moscal 23341*, HO). Use 200 µm scale for B, C, and F; 250 µm scale for A and D; and the 10 mm scale for G. Drawn by I.Ahonen.

Occurs in N.S.W. and Tas.; also in New Zealand, southern South America and widespread in the Northern Hemisphere. Grows in various open habitats, also in rather moist sites. Map 34.

N.S.W.: path to Wentworth Falls, Blue Mtns, *D.G.Catcheside 81.23* (AD). Tas.: Mt Rufus, *A.V.Ratkowsky 78/182* (HO); Middlesex Plains, *A.Moscal 1089* (HO); Adamson Peak, Dec. 1913, *L.Rodway* (HO); Cradle Mtn, Dec. 1971, *G.A.M.Scott* (MEL).

The Australian specimens are identical to those collected in New Zealand and Patagonia. Most of the plants I have studied from these areas closely resemble *P. formosum* from Japan and Taiwan, but the habitats in Australia (moist to wet peaty sites) resemble those preferred by *P. longisetum* Sw. ex Brid. The ranges of these two species overlap in the Northern Hemisphere, and *P. longisetum* has been recorded for South America and New Zealand. However, based on the present material, only *P. formosum* is tentatively accepted for Australia.

Polytrichastrum formosum has essentially unspecialised apical cells on its adaxial lamellae. The outer walls of these cells are neither incrassate nor papillose, and they have no special form and are quite peculiarly obliquely crenate when seen in side view. The only other large Australian species of Polytrichaceae with similar cells is *Dawsonia polytrichoides*, but that species is not present in Tasmania. Moreover, when capsules are present they are easily distinguished because of the extremely long and narrow peristome teeth of *Dawsonia*.

7. POLYTRICHUM

Jaakko Hyvönen[1]

Polytrichum Hedw., *Sp. Musc. Frond.* 88 (1801); from the Greek *poly* (many) and *trichos* (a hair), in reference to the hairy calyptra.

Type: *P. commune* Hedw.

Dioicous. Plants tightly to loosely caespitose, whitish green to brown. Stems erect, simple or branched. Rhizoids restricted to the stem base and the bases of the lowermost scale-like leaves. Leaves tightly appressed when dry, erect-spreading to distinctly recurved when moist; lamina linear-lanceolate, gradually narrowing to a sharp apex, with ovate to subquadrate abaxial cells; margin distinctly upcurved, unistratose; sheathing base ovate, gradually or abruptly narrowing to lamina, the sheath cells subquadrate to rectangular with firm walls; costa slightly excurrent, reddish brown, apically sharply serrate with abaxial teeth; lamellae covering almost the entire lamina. Calyptra hairy. Setae usually solitary, terminal or pseudolateral by subperichaetial innovation, smooth. Capsules inclined, pale to dark brown; urn box-like with 4 distinct angles; exothecial cells distinctly pitted, subquadrate, with firm walls; stomata restricted to the markedly swollen hypophysis; operculum rostellate. Peristome teeth 64, pale brown; epiphragm thin, attached to peristome teeth apices. Spores echinate.

While the number of described species of *Polytrichum* is close to 80, the actual number is certainly much lower. The genus is distributed in of both hemispheres. Represented in Australia by two non-endemic taxa, *Polytrichum* is a pioneer plant of open soil and peat.

1. Polytrichum commune Hedw., *Sp. Musc. Frond.* 88 (1801)

T: Europe; *n.v.*

Polytrichum perigoniale Michx., *Fl. Bor.-Amer.* 2: 293 (1803); *Polytrichum commune* Hedw. var. *perigoniale* (Michx.) Hampe, *Linnaea* 13: 44 (1839). T: Carolina, U.S.A.; holo: *n.v.*

Polytrichum brachypelma Müll.Hal., *Hedwigia* 36: 346 (1897). T: Sydney, N.S.W., *D.Kayser*; *n.v.*; Blue Mountains, N.S.W., 1884, *T.Whitelegge*; syn: H-BR.

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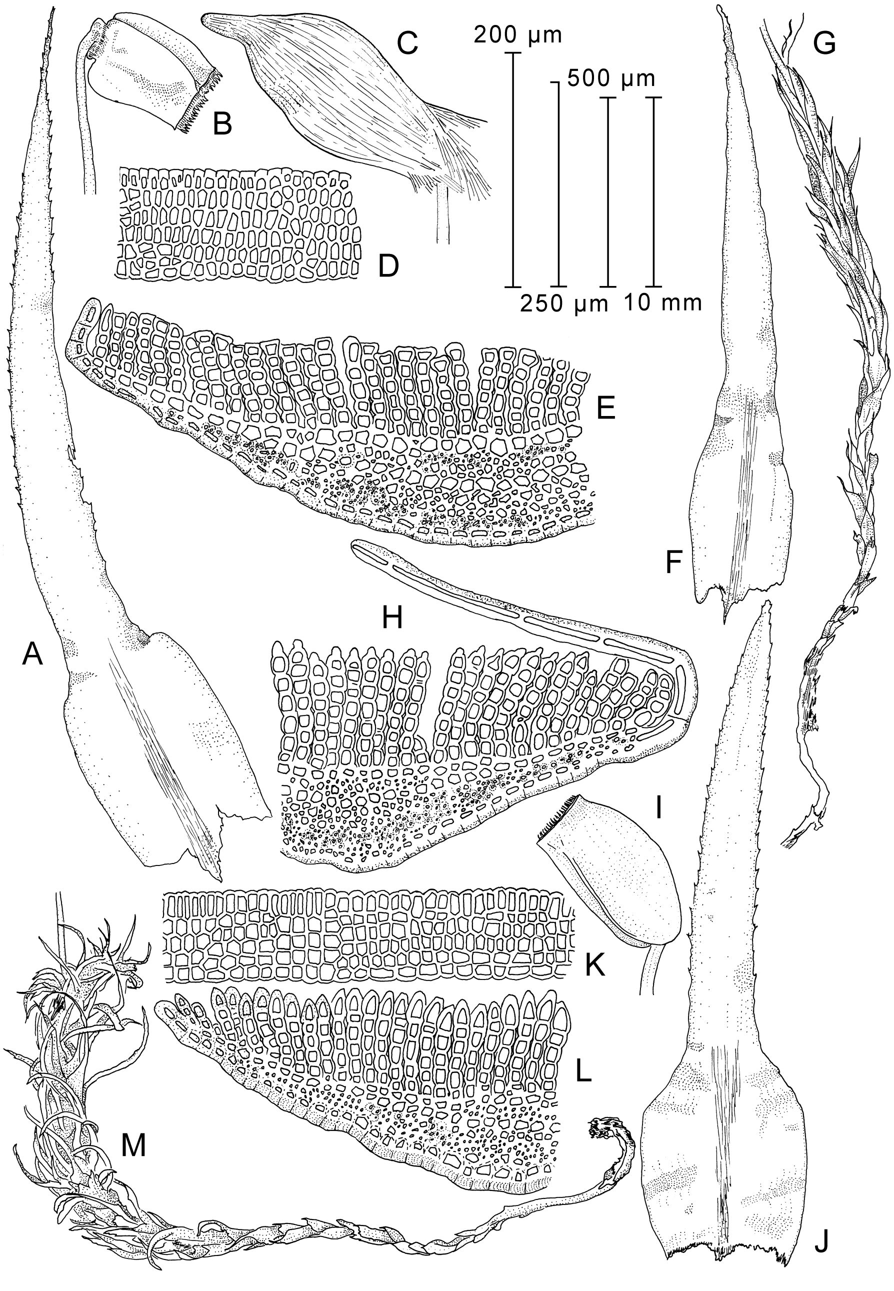

Figure 15. *Polytrichum* and *Polytrichadelphus*. **A–E**, *Polytrichum commune*. **A**, Leaf; **B**, Capsule; **C**, Immature capsule enclosed in hairy calyptra; **D**, Lamella in side view; **E**, T.S. of mid-leaf (A and C–E, *R.Hoogland 10022*, CANB; B, *N.Burbidge 3827*, CANB). **F–H**, *P. juniperinum*. **F**, Leaf; **G**, Habit (dry specimen); **H**, T.S. of mid-leaf (F–H, *A.Moscal 17323*, HO). **I–M**, *Polytrichadelphus magellanicus*. **I**, Capsule; **J**, Leaf; **K**, Lamella in side view; **L**, T.S. of mid-leaf; **M**, Habit (dry specimen) (**I**, *D.Norris 27339*, HO; **J–M**, *I.Stone 3071*, MEL). Use 200 µm scale for D, E, H, K and L; 250 µm scale for A, F and J; 500 µm scale for B, C and I; and 10 mm scale for G and M. Drawn by I.Ahonen.

Polytrichum cataractarum Müll.Hal., *Hedwigia* 36: 347 (1897). T: Fitzroy Falls, N.S.W., Nov. 1884, *T.Whitelegge*; iso: NSW.

Illustrations: H.A.Crum & L.E.Anderson, *Mosses of Eastern North America* 2: 1282, fig. 637 (1981); D.G.Long, *Bioscience* 17: 38, fig. 12 (1985); J.Beever, K.W.Allison & J.Child, *Mosses of New Zealand*, 2nd edn 27, fig. 12b (1992).

Stems to 18 cm tall. Leaves appressed when dry, distinctly squarrose when moist, 6.1–10.2 mm long; lamina 0.5–0.8 mm wide, abaxial cells with distinctly incrassate outer walls; margin serrate with large sharp unicellular teeth, tightly upcurved, unistratose, 4–8 cells wide; sheathing base gradually widened; costa excurrent, with apical abaxial teeth; lamellae 34–52, on adaxial surface of blade, 5–10 cells high, ±straight to slightly crenate by upper margin, with apical cells retuse in cross-section and with an incrassate outer wall. Urn 3.1–6.2 mm long, 1.6–3.5 mm wide. Spores 6–11 µm diam. n = 7, *fide* H.P.Ramsay, *J. Hattori Bot. Lab.* 82: 220 (1997). Fig. 15A–E.

Occurs in Qld, N.S.W., A.C.T., Vic. and Tas. Almost a cosmopolitan species with a distribution that includes New Zealand, the Pacific islands, Africa and South America. *Polytrichum commune* is a plant of diverse open habitats; it is commonly found on peat. Map 35.

Qld: S of Bald Rock, *I.G.Stone 13435* (MEL). N.S.W.: Sams Ck, *H.Streimann 49176* (CANB, H). A.C.T.: Bimberi Ra., *P.Darbyshire 80* (MEL). Vic.: Gorae West, *A.C.Beauglehole 1462* (MEL). Tas.: Mt Wellington, *A.V.Ratkowsky H363* (HO).

Polytrichum commune usually has rather distant leaves with glossy sheathing parts covering the stem. However, this is true only of specimens growing in moist habitats. The typical, retuse, apical cells of the adaxial lamellae are a reliable and readily seen diagnostic character that is present in all specimens. Two varieties (var. *commune* and var. *perigoniale*) have been distinguished in Australia, but their status is still in dispute, and they are not recognised here.

2. **Polytrichum juniperinum** Willd. ex Hedw., *Sp. Musc. Frond.* 90 (1801)

T: Switzerland; *n.v.*

Polytrichum juniperinum Willd. ex Hedw. var. *australe* Müll.Hal., *in* J.E.Zetterstedt, *Oefvers. Förh. Kongl. Svenska Vetensk.-Akad.* 24: 573 (1868). T: near Melbourne, Vic., *F.Mueller*; ***n.v.***

Polytrichum densifolium Hampe, *Linnaea* 30: 635 (1860), *nom. illeg.* (later homonym); *Polytrichum novae-hollandiae* A.Jaeger, *Ber. Tätigk. St. Gallischen Naturwiss. Ges.* 1873–74: 270 (1875). T: Mt Wellington, Tas., *F.Mueller*; *n.v.*

Polytrichum sullivanii Hampe, *Linnaea* 40: 316 (1876). T: between Mt Ararat and Mt William, Vic., *D.Sullivan*; lecto: H-BR, *fide* J.Hyvönen, *Fl. Australia* 51: 409 (2006); isolecto: BM, MEL.

Polytrichum tasmaniae Müll.Hal., *Hedwigia* 36: 343 (1897). T: Marydale, Tas., Dec. 1890, *O.Burchard*; *n.v.*

Polytrichum cypellomitrium Müll.Hal., *Hedwigia* 36: 343 (1897). T: Kangaroo Valley, near Moss Vale, N.S.W., Dec. 1885, *T.Whitelegge*; lecto: H-BR, *fide* J.Hyvönen, *Fl. Australia* 51: 409 (2006); Moss Vale, Fitzroy Falls, N.S.W, Nov. 1884, *coll. unknown*; syn: H, MEL, NSW, S;

Polytrichum ryparomitrium Müll.Hal., *Hedwigia* 36: 344 (1897). T: Liverpool, 20 miles [c. 32 km] S of Sydney, N.S.W., Nov. 1884, *T.Whitelegge*; iso: HBG, H-BR, NSW, S.

Polytrichum longipilum Müll.Hal., *Hedwigia* 36: 344 (1897). T: Studley Park, near Melbourne, Vic., 2 Aug. 1883, *F.M.Reader*; syn: S; outside Dimboola, Vic., 1892, *F.M.Reader*; *n.v.*; upper Ovens R., Vic., 1882, *McCann*; syn: JE; Grampians, Vic.; syn: *n.v.*; Daylesford, Vic., 1877, *R.Wallace*; syn: JE; Fowlers Bay, Vic., *coll. unknown*; syn: HBG, JE.

Polytrichum beccarii Müll.Hal., *Hedwigia* 36: 345 (1897). T: Mt Wellington, Tas., 19 Feb. 1878, *O.Beccari*; iso: H-BR.

Polytrichum nodicoma Müll.Hal., *Hedwigia* 36: 346 (1897). T: Oakleigh, Vic., 14 Sept. 1886, *F.M.Reader*; syn: HBG, S; outside Dimboola, Vic.; syn: H-BR.

Polytrichum tysdalei Müll.Hal., *Hedwigia* 36: 346 (1897). T: Gippsland, Vic., 1884, *H.Tysdale*; lecto: H-BR, *fide* J.Hyvönen, *Fl. Australia* 51: 409 (2006); isolecto: JE.

Polytrichum lycopodioides Müll.Hal., *Hedwigia* 36: 347 (1897). T: Tas.; *n.v.*

Polytrichum juniperum var. *australe* K.H.Walther, *Ann. Bryol.* 7: 149, fig. 8g–i (1934) *nom. illeg.* (later homonym), *non* Müll.Hal. (1868). T: Mt Wellington, Tas., 23 Dec. 1895, *W.A.Weymouth*; syn: H-BR.

Illustrations: H.A.Crum & L.E.Anderson, *Mosses of Eastern North America* 2: 1271, fig. 631 (1981); D.G.Long, *Bioscience* 17: 51, fig. 17 (1985); J.Beever, K.W.Allison & J.Child, *Mosses of New Zealand*, 2nd edn 27, fig. 11a–h; 56, pl. 5; 59, pl. 13 (1992).

Stems to 15.5 cm tall. Leaves tightly appressed when dry, erect-spreading when moist, 4.2–8.5 mm long; lamina 0.4–0.6 mm wide; abaxial cells with distinctly incrassate outer walls; margin entire, tightly incurved, partly covering adaxial lamellae, unistratose, 5–11 cells wide, with short broad cells; sheathing base gradually widened; costa forming a brown to hyaline arista with apical abaxial teeth; lamellae 32–52, on adaxial surface of lamina, 5–8 cells high, distinctly crenate by upper margin, with apical cells of central lamellae pyriform in cross-section and with the incrassate outer wall forming a distinct knob. Urn 3.7–6.6 mm long, 2.0–3.6 mm wide. Spores 9–14 µm diam. $n = 7$, *fide* H.P.Ramsay, *J. Hattori Bot. Lab.* 82: 220 (1997). Fig. 15F–G, Plates 10, 12.

Occurs in S.A., N.S.W., A.C.T., Vic. and Tas. An almost cosmopolitan species, *P. juniperinum* is a hardy plant of open habitats, and it can survive at very dry sites such as the tops of dry peat hummocks in mires. Map 36.

S.A.: Williamstown, southern Lofty Ra., *L.D.Williams 10381* (AD). A.C.T.: Mt Coronet, *N.T.Burbidge 6737* (CANB). Vic.: Bogong High Plains, *I.G.Stone 11314* (MEL). Tas.: Mt Wellington, *D.A. & A.V.Ratkowsky B78* (HO); Ben Lomond Natl Park, *A.V.Ratkowsky H369* (HO).

Polytrichum juniperinum is easily identified by the tightly appressed leaves with entire leaf margins that cover the adaxial lamellae. This makes the adaxial surface of the leaves glossy, a unique feature among Australian Polytrichaceae.

Doubtful and Excluded Names

Polytrichum piliferum Schreb. ex Hedw., *Sp. Musc. Frond.* 90 (1801)

Detailed study of Australian material did not reveal any specimens belonging to this taxon. Obviously, earlier records of the species for Australia are based on misidentification of stunted specimens of *Polytrichum juniperinum*.

Polytrichum recurvipilum Müll.Hal., *Hedwigia* 36: 343 (1897)

T: Braidwood district, N.S.W., Nov. 1884, *W.Baeuerlen*; *n.v.*

The type material of this species was not available for study, and it is impossible to identify the species from the original description. However, the name is likely to be superfluous, and if the type material can be located, this will probably fall into synonymy under *Polytrichum commune* or *Polytrichastrum longisetum*.

GIGASPERMACEAE

Ilma G. Stone†

Gigaspermaceae Lindb., *Öfvers. Förh. Kongl. Svenska Vetensk.-Akad*. 21: 592 (1865)

Type: *Gigaspermum* Lindb.

Plants small, with a pale fleshy branched subterranean rhizome. Primary stem without a central strand, leafless except for minute scales at the apices, producing sterile erect club-shaped male and female leafy aerial shoots. Rhizoids numerous, colourless. Aerial shoots often comose. Leaves cochleariform; margin entire to minutely serrulate; costa absent or (not in Australia) present; laminal cells large, smooth, lax, thin-walled. Calyptra minute, fleeting. Capsules erect, immersed or (not in Australia) exserted, globose to urn-shaped; operculum present or (not in Australia) absent, gymnostomous. Exothecial cells lax, thin-walled; stomata large at base of theca; guard cells 1 (not in Australia) or 2. Spores large.

A family of six small genera only one of which, *Gigaspermum*, occurs in Australia; also in the Mediterranean area, southern Africa, Madagascar, Central America (Mexico) and New Zealand. Formerly sometimes included in the Funariaceae.

V.F.Brotherus, Gigaspermaceae, *Nat. Pflanzenfam*., 2nd edn, 10: 314–316 (1924); A.J.Fife, The affinities of *Costesia* and *Neosharpiella* and notes on the Gigaspermaceae (Musci), *Bryologist* 83: 466–476 (1980); R.E.Magill, Gigaspermaceae, *Fl. Southern Africa: Bryophyta* 1(2): 299–303 (1987).

GIGASPERMUM

Gigaspermum Lindb., *Öfvers. Förh. Kongl. Svenska Vetensk.-Akad*. 21: 599 (1865); from the Greek *gigas* (giant) and *spermus* (-seeded), in reference to the very large spores.

Type: *G. repens* (Hook.) Müll.Hal.

Monoicous. Plants with an extensive perennial rhizome with erect shoots that often branch verticillately. Shoots numerous, short, forming low compact silvery turfs on soil. Leaves distant to overlapping, delicate, pale green or white, erecto-patent when dry, patent when moist, weakly or strongly cuspidate, often recurved; ecostate. Perichaetial leaves broadly ovate, upper ones much larger, white and papery at maturity; apex variable, narrowly acuminate, usually tapering to a long flexuose often recurved hairpoint; margin entire to denticulate above. Calyptra minutely mitrate. Setae rudimentary. Capsules immersed, urceolate; operculum a flattened dome with a minute apiculus. Spores angular.

A genus of two or three species, one of which occurs in Australia.

G.A.M.Scott & I.G.Stone, *The Mosses of Southern Australia* 250–252 (1976); I.Herrnstadt, C.C.Heyn & M.R.Crosby, New data on the moss genus *Gigaspermum*, *Bryologist* 83: 537–541 (1980); D.G.Catcheside, *Mosses of South Australia* 217–218 (1980); C.Delgadillo & A.Cardenas, Notes on ephemeral mosses from Mexico, including *Bruchia paricutinensis* sp. nov., *Bryologist* 94: 294–297 (1991).

Gigaspermum repens (Hook.) Lindb., *Öfvers. Förh. Kongl. Svenska Vetensk.-Akad*. 21: 599 (1865)

Anictangium repens Hook., *Musc. Exot*. 2: 8, pl. 106 (1819); *Anoectangium repens* (Hook.) Steud., *Nomencl. Bot*. 2: 58 (1824); *Schistidium repens* (Hook.) Brid., *Bryol. Univ*. 1: 120 (1826); *Physcomitrium repens* (Hook.) Müll.Hal., *Syn. Musc. Frond*. 2: 544 (1851); *Hedwigia repens* (Hook.) Wilson, *in* J.D.Hooker, *Fl. Nov.-Zel*. 2: 92 (‘1855’) [1854]; *Leptangium repens* (Hook.) Mitt., *J. Linn. Soc., Bot*. 4: 79 (1860). T: W.A., 1791, *A.Menzies*; holo: BM.

Gigaspermum subrepens Müll.Hal., *Genera Musc. Frond*. 130 (1900). T: Swan R., W.A., 1839–40, *L.Preiss*; B *n.v.* (probably destroyed).

Illustrations: G.A.M.Scott & I.G.Stone, *The Mosses of Southern Australia* 251, pl. 47 (1976); I.Herrnstadt, C.C.Heyn & M.R.Crosby, *Bryologist* 83: 539, fig. 2; 540, fig. 4 (1980); R.E.Magill, *Fl. Southern Africa: Bryophtya* 1(1): 295, fig. 84 (1981).

Autoicous. Vegetative shoots 1–5 mm long. Leaves often oblate, c. 0.5 mm long; laminal cells subquadrate, short-rectangular or rhomboidal, 20–25 µm wide. Male and female shoots numerous, to 20 or more, 1–3 mm tall, either formed simultaneously or the more slender male shoots first, followed and overtopped by the female shoots which can be lateral or form within a perigonium. Perigonial leaves to 1 mm long, reflexed, hairpointed; antheridia terminal, with filamentous paraphyses. Perichaetial leaves 2–5 mm long at maturity; laminal cells rectangular to rhomboidal, 70–130 × 20–25 µm. Capsules c. 1 mm wide, wide-mouthed after the loss of the operculum. Spores 100–150 µm, coarsely granulose, brown. Plates 11, 13.

Occurs in all Australian States and mainland Territories, but most common in inland, semi-arid areas on bare earth, red sandy loam, river silts and lateritic outcrops; also in higher rainfall areas on rocky limestone outcrops and rocky basaltic soils, from sea level to c. 1000 m. Also recorded from southern Africa, Madagascar, Mexico and New Zealand. Map 37.

W.A.: 54 km S of Nanutarra, *I.G.Stone 23507* (MEL). N.T.: Wallaby Gorge area, George Gill Ra., *A.C.Beauglehole* (MEL). S.A.: Koonalda, *I.G.Stone 6950* (MEL). Qld: Millstream Falls, Ravenshoe, *I.G.Stone 8628* (MEL). N.S.W.: Tibooburra, *I.G.Stone 5260* (MEL). Vic.: Boundary Bend, *I.G.Stone 1374* (MEL). Tas.: Rocky Tom, *K.Felton* (HO).

Plants growing in mallee areas can colonise square metres of undisturbed, bare ground with a low, dense silvery turf, surviving by perennial, oil-filled, rhizomatous underground stems and producing capsules in favourable seasons. On limestone ledges with higher rainfall, the aerial shoots are taller (to 10 mm), not as compact, and with distant lower leaves. The points on the leaves are extremely variable, and the appearance of the plant itself varies depending on the stage of development of the perichaetial leaves, a feature that is also influenced by climatic conditions. Once common on undisturbed roadsides, but now greatly reduced by weed cover and the use of fertilizers.

Gigaspermum subrepens was characterised by having more pointed leaves (Scott & Stone, 1976), while *G. mouretii* Corb., from the Mediterranean region, apparently differs only in having paroicous sexuality. It is doubtfully distinct from *G. repens*.

Excluded Name

Gigaspermum tumidum (Mitt.) Lindb. ex Paris, *Index Bryol*. 511 (1896)

Leptangium tumidum Mitt., *Trans. & Proc. Roy. Soc. Victoria* 19: 66 (1882). T: Tas., *W.Archer s.n.*; holo: NY *n.v.*, *fide* I.Herrnstadt *et al*., *op. cit*. 536 (1980).

This is synonymous with *Pleurophascum grandiglobum* Lindb. (Pleurophascaceae).

ARCHIDIACEAE

Ilma G. Stone†

Archidiaceae Schimp., *Coroll. Bryol. Eur.* 5 (1856).

Type: *Archidium* Brid.

Autoicous, paroicous or synoicous. Plants annual or perennial, gregarious or scattered, terrestrial, 3–30 mm tall, yellowish or green, rarely pinkish. Stems erect or prostrate, frequently branched by sterile and fertile innovations, usually with a central strand, 2 layers of large thin-walled inner cortical cells and an outer cortex of 1 or 2 layers of similar or distinctly smaller cells. Rhizoids smooth, pale to deep brown, sometimes with propagules. Leaves erect to spreading, often clasping at the base, narrowly oblong, linear, lanceolate or ovate; apex obtuse, acute to acuminate or subulate; margin plane, incurved or recurved, entire to serrulate; laminal cells smooth, variously shaped (often in the same leaf); costa subpercurrent to excurrent, rarely absent or failing in mid-leaf; cells usually ±uniform in cross-section. Gametoecia axillary or terminal. Perichaetial leaves mostly larger than stem leaves, sheathing; basal part often pale. Calyptra minute. Sporogone immersed. Setae absent. Capsules globose, cleistocarpous, gymnostomous; columella absent; exothecial cells large, irregularly hexagonal, yellowish to blackish; stomata absent. Spores few per capsule, large, polyhedral, 50–300 µm long; intine thick; exine smooth or papillose.

A monotypic family of approximately 30 species, widely distributed in tropical and temperate regions, but mostly native to Australia (16 species and three other distinct, but undescribed taxa) and Africa (14 species). Six of the named Australian taxa are endemic. The family was revised by J.A.Snider (1975) who divided it into two subgenera. Subgenus *Archidium*, the only one occurring in Australia, is further subdivided into four sections, three of which, *Nanarchidium* Snider, *Protobium* Müll.Hal. and *Phascoidea* G.Roth, occur in Australia.

The family is characterised by the unique sporogone and large, distinctive spores, a delicate calyptra consisting mostly of archegonial neck, with remnants often attached to the vaginula, a bulbous foot embedded in a cup-shaped vaginula, a sessile capsule lacking an apiculus, with a single-layered wall at maturity and separated from the spore sac by a bell-shaped airspace.

Opinions regarding some features of sporogone morphogenesis vary and have been discussed by Snider (1975) and Stone (1973, 1987). In contrast, the vegetative plant throughout the family is extremely variable and can resemble, for example, *Bryum*, *Campylopus*, *Eccremidium*, *Ditrichum*, *Splachnobryum* or *Ephemerum*. When lacking sporogones, species of *Archidium* are usually recognisable by a costa that lacks stereids, and readily deciduous innovations and perichaetia that join the stem by a single, short, haustorial cell. Regeneration commonly occurs by new shoots from buried, moribund stems and rhizoidal tubers which are not uncommon in several species. Plants are often soil-encrusted and eroded and this, combined with variation in shape and areolation of leaves from stem, branches and innovations, makes delimitation of species difficult. Several species are efficient soil binders, having seasonal increments by repeated fertile and sterile innovations and copious rhizoids that become infiltrated and compacted with soil.

G.Roth, *Aussereur. Laubm.* 1: 92–115 (1911); V.F.Brotherus, *Nat. Pflanzenfam.*, 2nd edn, 10: 155–156 (1924); I.G.Stone, Two new species of *Archidium* from Victoria, Australia, *Muelleria* 2: 191–213 (1973); J.A.Snider, Sporophyte development in the genus *Archidium* (Musci), *J. Hattori Bot. Lab.* 39: 85–104 (1975); J.A.Snider, A revision of the genus *Archidium* (Musci), *J. Hattori Bot. Lab.* 39: 105–201 (1975); R.E.Magill, Archidiaceae, *Fl. Southern Africa: Bryophyta* 1(1): 71–81 (1981); I.G.Stone, The development of the *Archidium* capsule: clarification of a misconception, *J. Bryol.* 14: 745–751 (1987); T.Arts & R.E.Magill, Rhizoidal tubers in *Archidium indicum* and *A. yunnanense* sp. nov., a new moss from China, *J. Bryol.* 18: 63–67 (1994); I.G.Stone, *Archidium clarksonianum*, a new moss species from Australia, *J. Hattori Bot. Lab.* 82: 271–279 (1997).

ARCHIDIUM

Archidium Brid., *Bryol. Univ*. 1: 747 (1826); from the Greek *archi* (first), referring to its presumed primitive nature.

Type: *A. phascoides* Brid. [= *A. alternifolium* (Dicks. ex Hedw.) Schimp.]

Description as for the family.

Bistratose juxtacostal cells are included in the costal width which is measured in transverse section throughout.

1 Costa absent or failing in mid-leaf; autoicous or paroicous; plants ephemeral....................................2

1: Costa subpercurrent, percurrent or excurrent; autoicous or, occasionally, with archegonia only; plants perennial..3

2 Plants stemless; protonema persistent, alga-like, green to red-brown; leaves ovate to lanceolate, minute, bract-like, ecostate; margin bluntly serrate; paroicous *(1)* .... **9. A. minutissimum**

2: Stems to c. 5 mm long; aerial and subterranean rhizoids with unicellular tubers; leaves mostly linear-lanceolate, lax, with the costa failing in mid-leaf; margin entire; autoicous........ **16. A. wattsii**

3 Protonema persistent, compact, cushion-like *(1:)*...**15. A. thalliferum**

3: Protonema usually lacking, or otherwise not persistent 4

4 Median cells of upper and perichaetial leaves variously quadrate, short-rectangular, trapezoidal or rhomboidal in the same leaf; if ±uniform, then alar cells of stem leaves quadrate to short-rectangular, not sharply differentiated in length from median cells [sect. *Phascoidea*] *(3:)* 5

4: Median cells of upper and perichaetial leaves usually uniform, either rhomboidal-hexagonal, linear-rhomboidal, long-rectangular or prosenchymatous; if areolation irregular the alar cells of stem leaves ±quadrate, much shorter than median cells, forming 2–8 rows of differentiated cells extending 4–16 or more cells along basal margin [sect. *Protobium*] 9

5 Innovation leaves julaceous or subjulaceous; stem and innovation leaves mostly less than twice as long as wide; margin plane to incurved (SE Australia) *(4)* 6

5: Innovation leaves not julaceous; stem and innovation leaves mostly more than twice as long as wide; margin plane to slightly recurved (mostly tropical) 7

6 Stem and innovation leaves with obtuse or truncate apices; margin cristate-denticulate; innovations julaceous *(5)* .... **5. A. clavatum**

6: Stem and innovation leaves with acute apices; margin ±entire to weakly crenulate; innovations subjulaceous or julaceous .... **13. A. stellatum**

7 Innovation and stem leaves lanceolate to narrowly triangular, acuminate; upper leaves to 1.5 mm long; costa usually percurrent; capsules terminal *(5:)* ....**11. A. rehmannii**

7: Innovation and stem leaves ovate to lanceolate, acute or acuminate; upper leaves to 1 mm long; costa usually subpercurrent or excurrent; capsules lateral and terminal 8

8 Costa of innovation leaves usually excurrent; perichaetial leaves narrowly acuminate or long-subulate; costa strongly excurrent or occasionally percurrent; epidermal cells of stem c. 10 µm wide *(7:)* ....**3. A. capense**

8: Costa of innovation leaves usually subpercurrent; perichaetial leaves with a short-ligulate flattened subula, often retrorse, occasionally gradually acuminate; costa usually subpercurrent; epidermal cells of stem 12–15 µm wide ....**17. Archidium** sp. **A**

9 Costa in middle of stem leaves 20–65 µm wide *(4:)*...10

9: Costa in middle of stem leaves 65–150 µm wide..18

10 Mid-leaf cells lax, rectangular, rhomboidal or fusiform, 50–130 × 12–30 µm; quadrate alar cells lacking; costa subpercurrent to percurrent *(9)* 11

10: Plants lacking this combination of characters..13

11 Perichaetial leaves with margins narrowly recurved above *(10)*................................ **14. A. subulatum**

11: Perichaetial leaves with margins plane or incurved 12

12 Mid-leaf cells rectangular to linear-rhomboidal, 4–8 times longer than wide; perichaetial leaves linear-lanceolate, narrowly acuminate to setaceous *(11:)* .... **7. A. indicum**

12: Mid-leaf cells mostly ellipsoidal-fusiform, to 4 times longer than wide; perichaetial leaves lanceolate to ovate or oblong-lanceolate, acute, sometimes short-acuminate ..... **4. A. clarksonianum**

13 Costa of upper stem leaves subpercurrent to percurrent, occasionally short-excurrent *(10:)* 14

13: Costa of upper stem leaves usually distinctly excurrent, sometimes hyaline at apex and forming a hairpoint 16

14 Stem leaves erect-appressed, ovate-lanceolate, acute, mostly to 3 times as long as wide; costa usually subpercurrent, occasionally percurrent *(13)* .... **2. A. brevinerve**

14: Stem leaves erecto-patent, ovate-lanceolate to triangular, often acuminate, 4 or more times as long as wide; costa subpercurrent to excurrent 15

15 Median cells of stem leaves mostly 30–50 µm long; costa with (2 or) 3 rows of adaxial cells, usually subpercurrent, rarely excurrent; costa of perichaetial leaves usually percurrent *(14:)* .... **1. A. birmanicum**

15: Median cells of stem leaves mostly 50–90 µm long; costa with 2 rows of adaxial cells, percurrent to short-excurrent; costa of perichaetial leaves excurrent .... **10. A. ohioense**

16 Stem leaves ovate to ovate-lanceolate; costa usually long-excurrent, frequently hyaline; perichaetial leaves usually less than 1 mm long, less than 3 times longer than wide; costa weak, not excurrent or short-excurrent from an acumen *(13:)* .... **12. A. rothii**

16: Stem leaves usually lanceolate; costa percurrent to short-excurrent; perichaetial leaves usually more than 1 mm long, c. 4 times longer than wide; costa usually excurrent, frequently hyaline 17

17 Plants 1.5–5.0 mm tall; median cells of perichaetial leaves 7–11 µm wide, narrowly prosenchymatous, usually very thick-walled *(16:)* .... **8. A. microthecium**

17: Plants 2–15 mm tall; median cells of perichaetial leaves 9–14 µm wide, rhomboidal to prosenchymatous, not thick-walled .... **10. A. ohioense**

18 Stem leaves lacking alar cells; median cells mostly ±rectangular, lax; costa usually less than 70 µm wide, with 2–5 rows of adaxial cells *(9:)* .... **7. A. indicum**

18: Stem leaves with alar and basal cells quadrate to short-rectangular; median cells mostly rectangular or rhomboidal; costa 70–150 µm wide, with 4–8 or more rows of adaxial cells 19

19 Costa of upper stem leaves usually excurrent or long-excurrent in a slender point *(18:)* .... **18. Archidium** sp. **B**

19: Costa of upper stem leaves subpercurrent or percurrent, occasionally short-excurrent 20

20 Stem leaves linear-lanceolate, loosely spreading, often ±squarrose, flexuose, deeply channelled, usually 5–7 times longer than wide; apex attenuated; margin usually plane; lamina at base of stem leaves 3–6 cells wide between margin and costa *(19:)* .... **19. Archidium** sp. **C**

20: Stem leaves lanceolate, erect to spreading, not flexuose, concave, mostly 3–5 times longer than wide; apex acute to acuminate; margin usually narrowly recurved; lamina at base of stem leaves more than 6 cells wide between margin and costa .... **6. A. elatum**

1. **Archidium birmanicum** Mitt. ex Dixon, *J. Indian Bot.* 2: 175 (1921)

T: Karwar, India, 1919, *Sedgwick* (*H.N.Dixon 6383*); holo: BM, *fide* J.A.Snider, *J. Hattori Bot. Lab.* 39: 143 (1975); iso: G, H-BR, L.

Illustrations: H.C.Gangulee, *Mosses of Eastern India and Adjacent Regions* 2: 173, fig. 79 (1971); J.A.Snider, *J. Hattori Bot. Lab.* 39: 179, pl. 18; 196, pl. 35 (344) (1975); A.Eddy, *Handb. Malesian Mosses* 1: 27, fig. 17 (1988).

Autoicous. Plants loosely tufted, lax, 5–25 mm tall. Stem in T.S. similar to that of *A. ohioense* (see below). Leaves suberect to laxly patent, lanceolate, 0.8–1.2 mm long, 3–5 times longer than wide; apex acute to acuminate; margin ±entire; costa usually subpercurrent, 35–50 µm wide, in T.S. ±hemispherical, with 2 or 3 large adaxial cells, otherwise similar to *A. ohioense*; laminal cells mostly in regular rows, rectangular to rhomboidal, in mid-leaf 20–40 × 8–12 µm, usually shorter towards margin and longer and broader towards costa, at base 30–80 × 10–15 µm; alar cells usually in 1 or 2 rows, mostly short-oblong to quadrate. Perigonia mostly terminal (not seen). Perichaetia lateral near apex. Perichaetial leaves somewhat broader than upper vegetative leaves; costa percurrent to slightly excurrent; laminal cells lax, mostly larger than in vegetative leaves. Sporogone not seen.

Occurs in northern N.T. and north-eastern Qld; also in India, Burma and New Guinea. Map 38.

N.T.: Hemple Bay, Groote Eylandt, *R.L.Specht M2* & *M3* (AD); c. 25 km NW of Jabiru, Kakadu Natl Park, *L.A.Craven & G.Whitbread 6791* (AD, CANB); Manton R., between Katherine and Darwin, *A.C.Beauglehole*

13784 (MEL). Qld: 2 km S of Wilderness Lodge, Cape York, *I.G.Stone 25597* (MEL); Lakefield Natl Park, Cape York, *I.G.Stone 25582* (MEL).

Distinguished from *A. indicum* by the abaxially more prominent costa and the denser areolation, and from *A. ohioense* by fewer, less well-defined, quadrate alar cells, denser areolation, and the costa of perichaetial leaves which is not long-excurrent.

The Hemple Bay specimen was originally reported as *Pseudephemerum nitidum* (Hedw.) Reim. (D.G.Catcheside, *in* R.L.Specht & C.P.Mountford, *Records of the American-Australian Scientific Expedition to Arnhem Land* 3(8): 169, 1958) and later as *A. indicum* (D.G.Catcheside & I.G.Stone, *J. Adelaide Bot. Gard*. 11: 2, 1988).

2. **Archidium brevinerve** P. de la Varde, *Rev. Bryol. Lichénol.* 6: 133 (1934)

T: Rochers de Coum près Nzamalèu, Gabon, *coll. unknown*; lecto: PC, *fide* J.A.Snider, *J. Hattori Bot. Lab.* 39: 140 (1975).

Illustrations: J.A.Snider, *J. Hattori Bot. Lab.* 39: 174, pl. 14; 197, pl. 36 (1975).

Autoicous. Plants 5–9 mm tall, green to yellowish green, gregarious. Stems erect, not flexuose, simple or 1- or 2-branched; epidermal cells much narrower than cortical cells, the latter with dense contents. Leaves erect-appressed when dry, erect to erecto-patent when moist, ±uniform except a few bract-like leaves below, channelled or concave, ovate to ovate-lanceolate, 0.6–0.9 mm long, 0.25–0.30 mm wide; apex acute to acuminate; margin entire, serrulate above, often partly recurved; costa usually subpercurrent, in mid-leaf 30–45 µm wide, in T.S. with cells ±undifferentiated, 2 or 3 adaxial, 1 or 2 central and 5–7 slightly smaller abaxial. Laminal cells firm-walled, fusiform to hexagonal or rhomboidal above, in mid-leaf rectangular or rhomboidal, 20–40 × 10–12 µm, at base 20–30 × 10–14 µm, in alar region quadrate to short-rectangular, 11–18 × 13–18 µm, in 3 or 4 rows, extending 5–10 cells up margin. Perichaetia axillary, ±sessile or on a very short branch. Perichaetial leaves as long as or slightly longer than vegetative leaves, more acuminate; costa percurrent to short-excurrent; laminal cells mostly broader, lax, rhomboidal, fusiform or rectangular, 15–40 × 10–15 µm, longer and rectangular below, 50–80 × 10–18 µm. Only immature capsules seen.

Very rare and known from only one locality in north-eastern Qld; also collected once in equatorial Africa. Map 39.

Qld: Murray Falls, N of Cardwell, *I.G.Stone 24920* (MEL).

Archidium brevinerve is reported for the first time from Australia, with the Australian specimen closely resembling the lectotype. It differs from *A. ohioense* and *A. rothii* in the subpercurrent costa and from *A. birmanicum* in the straight stem and the longer and less spreading perichaetial and stem leaves.

3. **Archidium capense** Hornsch., *Linnaea* 15: 135 (1841)

T: Cape of Good Hope, South Africa, 1827, *Ecklon*; lecto: H-BR; iso: S-PA, *fide* J.A.Snider, *J. Hattori Bot. Lab.* 39: 148 (1975).

Illustrations: G.Roth, *Aussereur. Laubm.* 1: pl. 10 (12) (1911); J.A.Snider, *J. Hattori Bot. Lab.* 39: 185; pl. 24; 198, pl. 37 (354) (1975); R.E.Magill, *Fl. Southern Africa: Bryophyta* 1(1): fig. 20 (1–10) (1981).

Autoicous. Stems 1–10 mm tall, sometimes branching by innovations from axils of outer perichaetial leaves or lower down, in T.S. with 1 or 2 rows of smaller c. 10 µm wide cells outside the large cortical cells. Leaves erect when dry, erecto-patent when moist, ovate or triangular to lanceolate 0.5–1.2 mm long; margin usually minutely serrulate; costa usually excurrent, filling subula, broad, channelled, 80–100 µm or more wide, in T.S. crescent-shaped, mostly 3 or 4 cells thick, with up to 8 large adaxial cells, abaxial side ±rough, with smaller often prorate cells; laminal cells not uniform in shape, narrower above, 30–50 × 5–10 µm, median cells 20–40 × 8–10 µm, alar cells 10–25 × 10–15 µm. Perichaetia terminal, often on almost leafless shoots, and terminal on short lateral branches, sometimes axillary, subsessile. Perichaetial leaves with a concave sheathing base, subulate, sometimes secund; margin slightly recurved in upper part of concave sheathing base; costa wide, filling subula,

usually excurrent, in T.S. as in stem leaves; laminal cells in mid-leaf ±rectangular to rhomboidal, 25–40 × c. 10 µm, narrower for a few marginal rows. Capsules immature.

Occurs in northern W.A., southern S.A. and north-eastern Qld; forms cushions on sandstone shelves. Also in South Africa. Map 40.

W.A.: summit of arm of Bungle Bungle Massif, SE Kimberley, *S.J.Forbes 2632* (MEL). S.A.: between Mitcham and Belair, *G.H.Bell 1503* (AD). Qld: near Frangipanni Bay, tip of Cape York Penin., *I.G.Stone 25591* (MEL); Porter Ck, Cardwell, *I.G.Stone 23150B*, *23152* (MEL); Davies Creek Rd, Mareeba, *I.G.Stone 12293D* (MEL).

Plants of two kinds occur in Australia: those from W.A. are smaller with stem and innovation leaves not much longer than wide, as in the type of *A. campylodium* Müll.Hal., a synonym of *A. capense* (Snider, 1975). Specimens from S.A. and Qld have longer, ovate to lanceolate leaves more like the type of *A. capense*, but sometimes with numerous axillary perichaetia near the base of longer stems, the terminal perichaetia on shorter shoots arising from old, buried stems.

4. **Archidium clarksonianum** I.G.Stone, *J. Hattori Bot. Lab*. 82: 271 (1997)

T: Wallaman Falls road, west of Ingham, Qld, *I.G.Stone 21207B*; holo: MEL.

Illustrations: I.G.Stone, *op. cit*. 271, fig. 1; 274, fig. 2; 275, fig. 3.

Plants perennial, 2–9 mm tall, yellow-brown, scattered or gregarious. Stems very lax, arising from buried stems of the previous year, from rhizoidal gemmae or from robust stoloniferous rhizoids, sometimes with lateral innovations from below the perichaetium. Rhizoids sometimes very coarse, with swollen brown moniliform thick-walled propagating cells. Leaves small and distant below, larger and comose above, ovate-lanceolate, oblong or lanceolate, 1.0–1.6 mm long, 0.3–0.5 mm wide; apex acute to short-acuminate; margin plane or incurved, entire to weakly crenulate, bordered (except at the apex and base) by a single row of narrow prosenchymatous cells 5–10 µm wide, with firm yellow walls; costa subpercurrent to percurrent, in mid-leaf 20–30 µm wide, in T.S. mostly with 2 large adaxial cells, 3 or 4 smaller abaxial and 1 or 2 central cells; laminal cells very lax, thin-walled, mostly prosenchymatous above, elliptic-fusiform in mid-leaf and rectangular at the base, 10–12 µm wide above, 70–130 × 15–30 µm in mid-leaf and base. Perichaetia terminal. Perichaetial leaves 1.4–2.4 mm long, similar to comal stem leaves; costa 30–50 µm wide, sometimes with a trace below mid-leaf.

Endemic to northern N.T. and north-eastern Qld; grows on damp, silty earth, often under *Melaleuca* trees, occasionally on roadside or creek banks in partial shade, usually mixed with other mosses but sometimes forming discrete colonies. Map 41.

N.T.: Jim Jim Falls, Kakadu Natl Park, *I.G.Stone 23435*, *23438* (MEL). Qld: c. 3 km S of Wilderness Lodge, Cape York Penin., *I.G.Stone 25598* (MEL); "Heathlands", Cape York Penin., 14 June 1984, *M.Godwin* [*I.G.Stone 23019*] (MEL); Kellahers, Cooktown, *I.G.Stone 25436 & R.Robertson* (MEL).

Archidium clarksonianum differs from *A indicum* in having perichaetial leaves that are lanceolate to ovate-lanceolate and less than 5 times as long as wide, fusiform-elliptical mid-leaf cells and consistently narrow marginal cells. The leaves are similar to those of the African *A. laxirete* P. de la Varde which was described by Snider (1975) as a synoicous, ephemeral moss.

5. **Archidium clavatum** I.G.Stone, *Muelleria* 2: 199 (1973)

T: Mt Tarrengower, near Maldon, Vic., 17 Oct. 1971, *I.G.Stone 7033*; holo: MEL; iso: DUKE, MEL.

Illustrations: I.G.Stone, *op. cit*. 200, fig. 58; 205, fig. 59; 207, fig. 60; pl. 25; J.A.Snider, *J. Hattori Bot. Lab.* 39: 191, pl. 30; 200; pl. 39 (361) (1975).

Autoicous. Plants 2–5 mm tall; branching, julaceous; sterile innovations 1 or 2, clavate, from the axils of lower perichaetial leaves. Leaves erect, appressed, broadly ovate, concave, c. 0.4–0.6 mm long; apex obtuse, often truncate; margin entire below, cristate-denticulate above; costa subpercurrent, broad, shallow, 60–100 µm wide; laminal cells 8–10 µm wide, short-rhomboidal to hexagonal above, short-rectangular below. Perigonia terminal on short

branches. Perichaetia terminal. Perichaetial leaves 7–9; upper ones c. 1.3–1.5 mm long; costa and margin as in vegetative leaves; laminal cells irregularly 3–5-sided, in mid-leaf mostly rhomboidal or trapezoidal, c. 11–16 µm wide and 3–4 times longer than wide, incrassate, mostly smaller in marginal and apical regions; at base with a marginal strip of pale thin-walled ±rectangular cells.

Known from only one locality in central Vic.; grows embedded in gravelly detritus with gelatinous algae, lichens and bryophytes in a depression in granite rock; also reported from Brazil (D.M.Vital, pers. comm.). Map 42.

Vic.: Mt Tarrengower, near Maldon, *I.G.Stone 7088* (MEL).

This species is characterised by the cristate-denticulate margins of the vegetative and perichaetial leaves, the denticulations usually composed of finger-like projections from distal and proximal ends of adjoining cells.

6. Archidium elatum Dixon & Sainsbury, *in* G.O.K.Sainsbury, *Trans. Roy. Soc. New Zealand* 75: 169 (1945)

T: Ahipara, Northland, New Zealand, *H.B.Matthews 335* [*Sainsbury 961*]; holo: WELT; iso: BM, NY, S-PA.

Illustrations: G.O.K.Sainsbury, *Bull. Roy. Soc. New Zealand* 5: 71, pl. 9, fig. 1 (1955); J.A.Snider, *J.Hattori Bot. Lab.* 39: 181, pl. 20 (200–205); 196, pl. 35 (347) (1975).

Australian plants sterile. Stems 0.7–20 mm tall, simple or branched, in T.S. with outer cortex of 2 layers of small cells. Leaves erecto-patent, crowded above, spreading below, clasping, concave, narrowly lanceolate, 0.6–1.5 mm long, 0.15–0.30 mm wide; apex acute or acuminate; margin often narrowly recurved in mid-leaf, entire or weakly serrulate above; costa subpercurrent to percurrent, in mid-leaf 80–120 µm wide, in T.S. crescent-shaped, 2 or 3 cells thick, with up to 8 adaxial cells; laminal cells near leaf apex c. 5–10 µm wide, prosenchymatous, in mid-leaf rectangular to oblong-rhomboidal, 20–40 × 9–12 µm, in alar region subquadrate to short-rectangular, c. 10–12 µm wide, often extending to a quarter of the leaf length, at base usually with more than 6 cells between costa and margin. Perichaetia axillary or terminal. Inner perichaetial leaves oblong, sheathing, contracted to a subula; margin often narrowly recurved above mid-leaf; costa similar but narrower than in stem leaves; cells of limb narrowly hexagonal, rectangular to rhomboidal, c. 35–55 × 10–15 µm, in sheath very thin-walled, loosely hexagonal, c. 50–70 × c. 15 µm, gradually shorter upwards, with marginal cells narrower and shorter.

Gregarious and binding sandy soil on creek banks or in rock crevices in north-eastern Qld and near Sydney, N.S.W.; also in New Zealand. Map 43.

Qld: Blencoe Ck, Herberton, *I.G.Stone 22422*, *22423*, *23238* (MEL); Attie Ck, Cardwell, *I.G.Stone 22361*, *23178* (MEL). N.S.W.: Ku-ring-ai Chase Wildflower Reserve, near Sydney, *I.G.Stone 17653* (MEL).

7. Archidium indicum Müll.Hal., *Flora* 71: 8 (1888)

T: Northern Pegu Yomah, Burma, *S.Kurz 2889*; lecto: S-PA; *fide* J.A.Snider, *J. Hattori Bot. Lab.* 39: 145 (1975); isolecto: FH, L, NY, S-PA.

Illustrations: G.Roth, *Aussereur. Laubm.* 1: t. 11 (9a–c) (1911); J.A.Snider, *J. Hattori Bot. Lab.* 39: 181, pl. 20 (193–199); 196, pl. 35 (345) (1975).

Sterile. Plants scattered or tufted, 3–20 mm tall, yellow to yellow-brown. Stems simple or branched, lax; tubers moniliform. Leaves lax, usually distant, erecto-patent, linear-lanceolate to elliptic, 0.7–1.5 mm long, c. 4–8 times longer than wide; apex acuminate or acute; margin entire; costa subpercurrent to percurrent, 30–70 µm wide, in T.S. 3 cells thick with mostly 3–5 thin-walled adaxial cells, abaxial cells usually similar, central cells few, similar or substereid; laminal cells thin-walled, loosely rectangular, in mid-leaf 50–100 × 12–20 µm (some shoots with median cells only 7–10 µm wide), narrower above and sometimes at margins, at base mostly 12–25 µm wide. Perigonia not seen. Perichaetia terminal on short suberect branches or lateral. Perichaetial leaves lanceolate-subulate or linear-lanceolate, gradually acuminate or setaceous, 1.8–2.4 mm long, 5–8 times longer than wide; costa subpercurrent or percurrent; laminal cells thin-walled, rectangular to rhomboidal, at apex

40–60 µm long and c. 10 µm wide, in mid-leaf 60–150 × 12–20 µm wide, at margin sometimes narrower, at base shorter and wider. Sporophyte not seen.

Occurs in monsoonal forests in northern W.A. and N.T.; also in India, Sri Lanka and Burma. Map 44.

W.A.: Maragui Promontory, Prince Regent River Reserve, West Kimberley, *K.F.Kenneally 2124* (MEL, PERTH); King Edward R., *D.J.Edinger 581* (AD). N.T.: Malabanbandju, Kakadu Natl Park, *I.G.Stone 23364*, *23365* (MEL); Katherine Gorge, *L.A.Craven 6740* (AD, CANB); Tallaputta Spring, *J.H.Willis s.n.* (AD, MEL).

The Australian plants appear to be closest to *A. indicum*, with similar costal structure but mostly with shorter leaves. However, as in the holotype, plants, even individuals of the same colony, are often very variable in areolation.

8. Archidium microthecium Dixon & P. de la Varde, *in* P. de la Varde, *Ann. Cryptog. Exot.* 1: 37 (1928)

T: Kodaikanal, India, *Foreau 211*; holo: BM; iso: PC *n.v*.

Illustrations: J.A.Snider, *J. Hattori Bot. Lab.* 39: 176, pl. 15 (125–134); 198, pl. 37 (355) (1975); R.E.Magill, *Fl. Southern Africa: Bryophyta* 1(1): fig. 18 (17–22) (1981).

Autoicous. Plants 1.2–5.0 mm tall; innovations subperichaetial, usually with rhizoids at base. Leaves bract-like below, lanceolate above, 0.4–0.9 mm long, 0.17–0.20 mm wide; apex acute or acuminate; costa rounded, 25–35 µm wide, percurrent or excurrent in a brittle arista to 250 µm long; median laminal cells rhomboidal to prosenchymatous, 25–50 µm long, usually incrassate; alar cells thinner-walled, often quadrate to short-rectangular, 8–11 µm wide. Perigonia usually terminal; perigonial leaves 3 or 4, the outermost lanceolate, to 0.7 mm long, with an excurrent costa; inner 2 short, ovate-apiculate, 0.3–0.4 mm long. Perichaetia subterminal, subsessile or sometimes terminal. Perichaetial leaves oblong-lanceolate, acuminate, 0.7–1.2 mm long; margin entire to weakly serrulate, sometimes narrowly recurved above; costa narrow, 30–40 µm wide, usually long-excurrent; cells in mid-leaf prosenchymatous, 60–100 × 10–12 µm, thick-walled with narrow lumina, rectangular below, hyaline in the alar region. Sporophyte not seen.

Rare in N.T. and north-eastern Qld; also in South Africa and India. Map 45.

N.T.: Katherine Gorge, *I.G.Stone 23309 p.p.* (MEL). Qld: Porter Ck, Cardwell, *I.G.Stone 23150.01* (MEL).

The stems are often almost leafless, with a terminal perigonium and subtending perichaetia in the N.T. collections, whereas in the Qld material the perichaetia are terminal on the main stem and lateral branches.

9. Archidium minutissimum I.G.Stone, *J. Bryol*. 13: 353 (1985)

T: S of Cooktown, Qld, 5 June 1984, *I.G.Stone 22050*; holo: MEL; iso: MEL.

Illustrations: I.G.Stone, *op. cit*. 354, fig. 1; 355, fig. 2.

Paroicous. Plants *Ephemerum*-like, almost acaulescent, 0.3–0.8 mm tall; protonema persistent, alga-like, pale green, reddening with age. Leaves, including perichaetial leaves, few, scale-like, erecto-patent or secund, green to red-brown, ovate or lanceolate, 0.2–0.7 mm long, ecostate; apex acute to finely acuminate, twisted or truncate; margin bluntly serrate; laminal cells elongate-rectangular to rhomboidal, 30–70 × 10–15 µm. Antheridia solitary in leaf axils. Capsules minute, 200–250 µm diam. Spores 16 (–36), 70–100 µm long.

Endemic to north-eastern Qld, at bases of *Melaleuca* trees bordering freshwater lagoons and mangrove swamps subject to inundation at extreme high tides; very rare, known only from a few localities near Cooktown. Map 46.

Qld: near mouth of Alligator Ck, Finch Bay, Cooktown, *I.G.Stone 22016*, *22020* (MEL); Cooktown Botanic Gardens, *I.G.Stone 22033* (MEL).

Not found since the original collections were made in 1984.

10. Archidium ohioense Schimp. ex Müll.Hal., *Syn. Musc. Frond.* 2: 517 (1851)

T: Ohio, U.S.A., *Sullivant Musci Allegh. 213*; lecto: FH-SULL *n.v.*, *fide* J.A.Snider, *J. Hattori Bot. Lab.* 39: 135 (1975); isolecto: BR, CU, FH, G, L, LD, MICH, MIN, NY, US, W; all *n.v.*

Illustrations: J.A.Snider, *op. cit.* 172, pl. 11; 173, pl. 12; 195, pl. 34 (1975); H.A.Crum & L.E.Anderson, *Mosses of Eastern North America* 1: 76, fig. 28; 77, fig. 29 (1981).

Autoicous. Stems 2–15 mm long, in T.S. with epidermal cells not much narrower than cortical cells. Leaves closely set, erect to erecto-patent, concave, amplexicaul, linear-lanceolate, 0.5–1.2 mm long, 3–6 times longer than wide; apex acuminate; margin ±entire; costa usually percurrent, sometimes excurrent, 25–40 µm wide, in T.S. round to semicircular, mostly 4 or 5 cells thick, with 2 large adaxial cells and central cells substereid; alar cells quadrate to short-rectangular, 12–15 µm wide, reaching to c. 12 cells up margin; median cells ±rhomboidal to elongate-hexagonal, 50–80 (–110) × 10–40 µm. Gametoecia usually axillary. Perigonial leaves with costa usually excurrent. Perichaetial leaves ovate-lanceolate, 1.2–2.0 mm long, c. 4 times longer than wide, acuminate; costa excurrent, 35–50 µm wide. Capsules c. 400 µm diam. Spores c. 165 µm.

Occurs in north-eastern Qld; also in North America, West Indies, Africa, Mascarene Is., Sri Lanka, India, China, Japan and New Caledonia. Map 47.

Qld: Millstream Falls, *I.G.Stone 19776* (MEL).

Capsules, so far only found axillary in Australian material, can be either terminal or lateral in American and African specimens. *Archidium ohioense* can be distinguished from *A. birmanicum* by the more tapered leaves, more regular median cells, more distinct alar cells and a usually long-excurrent costa of perichaetial leaves; from *A. rothii* by the longer and narrower stem leaves with percurrent (or short-excurrent) costa, longer laminal cells, quadrate alar cells that do not reach as far up the margin, and by the much larger perichaetial leaves with long-excurrent costae.

11. Archidium rehmannii Mitt., *J. Linn. Soc., Bot.* 22: 300 (1886)

T: Cape Town, South Africa, *Rehmann*; holo: NY; iso: S-PA.

Illustrations: G.Roth, *Aussereur. Laubm.* 1: pl. 11 (8) (1911); J.A.Snider, *J. Hattori Bot. Lab.* 39: 184, pl. 23; 201, pl. 40 (365) (1975).

Autoicous. Plants 5–15 mm tall; innovations numerous, subapical or from within perichaetia, as long as fruiting plant. Stems in T.S. with outer 1 or 2 rows of cells much narrower than cortical cells. Leaves erecto-patent when dry, patent when moist, ovate-lanceolate below, lanceolate above, to 1.5 mm long; apex acute to acuminate; margin entire to weakly serrulate; costa 50–70 µm wide, percurrent or slightly excurrent, in T.S. crescent-shaped, 2–4 cells thick; mid-leaf cells irregularly 4-sided, 10–30 × 8–10 µm, narrower towards margin, longer above. Perichaetia terminal. Perichaetial leaves broadly ovate-lanceolate, often falcate, abruptly subulate; costa crescent-shaped, percurrent to excurrent; laminal cells in mid-leaf mostly rhomboidal, 30–60 × 10–11 µm, narrower towards margin. Capsules terminal. Spores c. 160 µm.

Occurs in W.A. in swampy areas on bare sand, mixed with *Leptocarpus aristatus* and *Eccremidium pulchellum*. Also in South Africa. Map 48.

W.A.: Yule Brook Reserve (Cannington Swamp), 20 km SE of Perth, *R.Wyatt & A.Stoneburner 4118* (PERTH); Coomalloo, *I.G.Stone 6005* (MEL).

This species is characterised by the innovations with stiffly erect, narrowly lanceolate leaves with broad costae. Capsules are rare in Australia.

12. Archidium rothii Watts ex G.Roth, *Hedwigia* 54: 267 (1914)

T: Alice Springs, "Qld", [N.T.], *coll. unknown*; holo: S-PA; iso: NSW.

Illustrations: G.Roth, *Aussereur. Laubm.* pl. 10, fig. 6 (1914); J.A.Snider, *J. Hattori Bot. Lab.* 39: 178, pl. 17; 197, pl. 36 (350) (1975); D.G.Catcheside, *Mosses of South Australia* 60, fig. 8 (1980).

Autoicous. Stems 5–10 mm long, in T.S. similar to *A. ohioense* (see above). Leaves usually crowded, erect to erecto-patent, ovate to ovate-lanceolate, acuminate, 0.60–0.95 mm long, 0.3–0.5 mm wide; costa 35–42 µm wide, excurrent in a long and often spinulose arista, in T.S. similar to *A. ohioense*; laminal cells in mid-leaf rhomboidal-hexagonal, 23–70 × 11–14 µm, in alar region quadrate, 12.5–23.0 µm wide, extending half to two-thirds up the margin. Moniliform rhizoidal gemmae sometimes present. Perigonia axillary; bracts ovate, apiculate, 0.20–0.45 mm long, the costa weak or absent. Perichaetia usually axillary, sessile. Perichaetial leaves broadly sheathing, sometimes convolute, usually 0.5–1.0 mm long, 0.25–0.35 mm wide; apex narrowly acuminate; margin usually entire, often incurled; costa usually c. 26 µm wide, percurrent to short-excurrent; laminal cells thin-walled, lax, rhomboidal or prosenchymatous, 45–80 × 13–18 µm. Sporogone not seen.

Endemic, common and widespread in inland to coastal areas of northern W.A., central and northern N.T., and in eastern Qld from Cape York south to Maryborough. An efficient earth-binder that forms dense turfs with numerous branches arising from old buried stems; often on earth paths with a compacted surface. Map 49.

W.A.: Halls Creek, *I.G.Stone 23498* (MEL). N.T.: Mount Olga Gorge, *D.G.Catcheside 76.312* (AD, MEL). Qld: Christmas Ck, *M.Godwin* [*I.G.Stone 23021*] (MEL); Frangipanni Beach, Cape York, *I.G.Stone 25591* (MEL); Ferry St, Maryborough, *I.G.Stone 25815* (MEL).

Archidium rothii is distinguished from *A. ohioense* by the broader stem leaves, often with hoary points, alar cells extending further up the leaf margin, perigonial leaves with the costa weak or absent and shorter perichaetial leaves with the costa not or only slightly excurrent. The attenuated, twisted acumen can sometimes be mistaken for an excurrent costa.

13. **Archidium stellatum** I.G.Stone, *Muelleria* 2: 192 (1973)

T: near Neilborough, Vic., 14 Nov. 1968, *I.G.Stone 30*; holo: MEL; iso: MEL, NSW.

Illustrations: *I.G.Stone*, *op. cit.* 193, fig. 55; 195, pl. 23; 197, fig. 56; 198, fig. 57; J.A.Snider, *J. Hattori Bot. Lab.* 39: 189, pl. 28; 201, pl. 40 (364) (1975); D.G.Catcheside, *Mosses of South Australia* 58, fig. 6; 59, fig. 7 (1980).

Autoicous. Plants perennial, c. 3–5 mm tall. Stems erect, with a terminal perichaetium, branching within the perichaetium by 1–7 julaceous or subjulaceous innovations, bearing capsules at their apices. Leaves broadly ovate, apiculate, 0.1–0.5 mm long; margin entire to weakly crenulate; costa subpercurrent to percurrent; laminal cells quadrate to short-rectangular, in mid-leaf 10–20 × 8–10 µm. Perigonia bud-like, terminal on lateral branches. Perichaetial leaves 1.0–1.9 mm long, ovate, abruptly narrowed to a short subula; margin ±entire, sometimes slightly incurved; costa usually percurrent, in mid-leaf 90–100 µm wide; laminal cells in mid-leaf irregularly rectangular to rhomboidal, mostly 25–80 × 8–12 µm, shorter at margins, hyaline in alar region. Capsules 340–450 µm diam. Spores 140–150 µm, smooth to faintly ornamented.

Endemic to Vic. and south-eastern S.A.; common as dense turfs on road verges in lightly forested country and grassland. Map 50.

S.A.: Bellevue Heights, above Sturt Valley, Adelaide, *D.G.Catcheside 71.941* (AD). Vic.: Moyston, *I.G.Stone 210* (MEL); Wannon Falls, *I.G.Stone 9279* (MEL); Yarra Glen, *I.G.Stone 14428 p.p.* (MEL).

Habit variability is usually a response to levels of illumination; plants tend to be short and compact in full light, very elongated in very shaded habitats.

14. **Archidium subulatum** Müll.Hal., *Flora* 71: 7 (1888)

T: Cape of Good Hope, South Africa, 1876, *Rehmann*; lecto: S-PA, *fide* J.A.Snider, *J. Hattori Bot. Lab.* 39: 144 (1975).

Illustrations: G.Roth, *Aussereur. Laubm.* 1: Taf. 12 (10) (1911); J.A.Snider, *op. cit.* 180, pl. 19; 196, pl. 35 (346) (1975).

Autoicous. Plants densely tufted, 4–14 mm tall, pale green to yellowish. Fertile stems simple or fasciculately branched with both female and sterile subperichaetial innovations. Leaves distant, ±uniform, 0.5–1.0 mm long, less than 4 times as long as wide, erecto-patent, ovate-

lanceolate or narrowly lanceolate, acuminate; margin plane, sometimes recurved in uppermost part, entire to serrulate above; costa narrow, 20–40 µm wide, subpercurrent, filling leaf apex or slightly excurrent; laminal cells rhomboidal to prosenchymatous above, 30–70 × 7.5–10 µm, gradually wider, 10–20 µm wide, and more rectangular in mid-leaf and below, at base 17–25 µm wide, often quadrate near insertion. Perichaetial leaves whitish, 1.5–1.8 mm long, c. 5 times as long as wide, concave from an ovate to broadly ovate sheathing basal part, gradually lanceolate-subulate; margin narrowly recurved above, entire or serrulate; costa 40–90 µm wide, filling the subula; laminal cells laxly rectangular or rhomboidal, in mid-sheath 80–130 × 15–20 µm, at base lax, shorter-rectangular to 6-sided, 40–60 × 20–30 µm. Sporogone not seen.

Very rare in northern N.T.; also in South Africa. Map 51.

N.T.: 25 km NW of Jabiru, Kakadu Natl Park, *L.A.Craven & G.Whitbread 6792* (AD, CANB).

Archidium subulatum is readily distinguished from the other Australian species with large, lax rectangular cells (*A. indicum* and *A. clarksonianum*) by the narrowly recurved margin of the large, pale perichaetial leaves. The costa in mid-perichaetial leaf is sometimes duplicated with one or two cells between the two strands.

15. **Archidium thalliferum** I.G.Stone, *J. Bryol*. 13: 345 (1985)

T: top of Island Stack, Lawn Hill Gorge Natl Park, Qld, 29 June 1984, *I.G.Stone 22190*, *A.G.Stone & R.Langford*; holo: MEL; iso: BM, BRI, MEL.

Illustrations: I.G.Stone, *op. cit*. 348, fig. 1; 350, fig. 2; 351, fig. 3.

Autoicous. Plants 1.0–1.5 mm tall. Stems 0.1–0.5 mm long, soft, often subterranean; branches few, short, clustered; protonema highly specialised, persistent, cushion-shaped, thalloid, c. 1.0 mm across and 0.6 mm deep, the upper surface greyish white, the centre chlorophyllose; rhizoid system extensive; propagules tuber-like. Leaves erect to suberect, ovate, oval or lanceolate, 0.2–0.8 mm long, 0.2–0.4 mm wide, acute to acuminate; costa percurrent to excurrent, c. 50 µm wide; margin entire to weakly serrulate; cells in mid-leaf rhomboidal to prosenchymatous, 50–70 × 12–15 µm; marginal cells smaller, ±rectangular. Perigonia sessile below perichaetia; leaves often ecostate. Perichaetial leaves 0.9–1.2 mm long, 0.30–0.45 mm wide; costa excurrent. Capsules 320–350 µm diam. Spores (50–) 70–110 µm long, smooth to granulose.

Known only from the type locality in semi-arid, north-western Qld on thin, exposed soil on sandstone, associated with *Riccia* spp., lichens and blue-green algae. Possibly also in the Kimberley region of W.A. Map 52.

Qld: Island Stack, Lawn Hill Gorge, *I.G.Stone 22189* (MEL); Painted Pool, Lawn Hill Gorge, *I.G.Stone 22175* (MEL).

Archidium thalliferum is unique among mosses in having a perennial, pseudoparenchymatous, thalloid protonema differentiated into three zones with protective, photosynthetic and storage functions. The specimen from Painted Pool is atypical with longer stems. It has rhizoidal tubers, and barren plants grow from pieces of moribund, protonematal tissue.

A specimen from W.A. (Kimberley, *G.A.M.Scott*, MEL 662) has leaf shape, cells and rhizoidal gemmae that match the type. However, no protonematal cushions were seen.

16. **Archidium wattsii** (Broth.) I.G.Stone, *J. Bryol*. 13: 153 (1984)

Splachnobryum wattsii Broth., *Oefvers. Förh. Finska Vetensk.-Soc.* 42: 99 (1900). T: Parsley Bay, N.S.W., Feb. 1899, *W.W.Watts 2479*; lecto: H-BR, *fide* I.G.Stone, *loc. cit*.; isolecto: NSW; Watsons Bay, N.S.W., 27 Feb. 1899, *W.W.Watts 2450*; syn: H-BR, NSW.

Illustrations: I.G.Stone, *op. cit*. 154, fig. 1; 155, fig. 2.

Autoicous. Plants ephemeral. Stems c. 0.2–2.0 mm long, lax, usually with a terminal perigonium and a few subterminal fertile innovations; rhizoids at base of stems, innovations and basal leaf cells; vegetative propagules golden, globose, single-celled, 120–150 µm diam., on rhizoids above and below ground. Leaves glossy, iridescent, erecto-patent to patulous,

linear to lanceolate, 0.4–2.3 mm long; apex acute; costa ending about mid-leaf, to 100 µm wide, in T.S. with thin-walled cells, homogeneous, or adaxial ones smaller; margin entire, plane; laminal cells lax, thin-walled, rectangular to irregularly hexagonal, mostly 75–150 × c. 25–40 µm. Capsules c. 250–400 µm diam. Spores c. 150 µm long, densely and finely papillose, brown.

Endemic and very rare in eastern N.S.W. and Qld; transitory on sandy or gravelly soil or decaying rock in damp places under cliffs, but also in drier areas in light shade of trees (after sufficient rain). Map 53.

Qld: Cania Gorge Natl Park, near Monto, *I.G.Stone 21066* (BRI, MEL); Emerald to Fairbairn Dam, *I.G.Stone 21185* (MEL). N.S.W.: Abbotsford, near Sydney, *W.W.Watts 6749* (NSW).

Archidium wattsii is closest to *A. minus* (Renauld & Cardot) Snider from the U.S.A. and *A. laxirete* P. de la Varde from Africa, both of which are also ephemeral with lax, thin-walled cells. They differ in being synoicous and having much longer costae and an apparent lack of vegetative propagules.

17. **Archidium** sp. **A**

Autoicous. Plants 5–10 mm tall. Stems in T.S. with epidermal cells 12–15 µm wide; innovations few, short, arising between or below lower perichaetial leaves. Leaves sparse, erecto-patent when dry, patent when moist, concave, amplexicaul, ovate or lanceolate, 0.5–0.9 mm long; apex acute to acuminate; margin serrulate, mostly recurved in mid-leaf; costa 60–80 µm wide in mid-leaf, subpercurrent to percurrent, in T.S. crescent-shaped, 2 or 3 cells thick with up to 6 large adaxial cells, abaxial cells numerous, smaller; laminal cells near apex short and narrow, 20–35 × 5–7 µm; in mid-leaf irregularly rectangular to rhomboidal, 20–60 × 10–15 µm; in alar region quadrate to short-rectangular, 10–15 µm wide. Perigonia few, axillary. Perichaetia terminal, clustered at the stem apex and on lower lateral branches, or subsessile in leaf axils, sometimes numerous. Perichaetial leaves often secund, concave, to 1.5 mm long, the inner leaves oblong, sheathing, abruptly or gradually narrowed to a flat serrulate often retrorse ligulate subula, at least one-quarter of the leaf length; apex acute or obtuse; margin partly recurved, serrulate above; costa subpercurrent, widest (to 90 µm) in mid-leaf; laminal cells irregularly rectangular to rhomboidal, large, lax and pale in alar regions. Only immature capsules seen.

Occurs in north-eastern Qld at the bases of cliffs in gallery forest; also in central Qld on earth banks in brigalow forest. Map 54.

Qld: Dawson Hwy, Moura, *I.G.Stone 21152* (MEL); c. 15 km past Moura, Dawson Ra., *I.G.Stone 21164* (MEL); Finch Bay, Cooktown, *I.G.Stone 25472* (MEL); Dalrymple Ck, Cardwell, *I.G.Stone 21398* (MEL).

This unnamed moss is characterised by the subpercurrent, crescent-shaped costa, partly narrowly recurved margin and the flat, serrulate subula of perichaetial leaves. Innovations are short, eventually fertile at the apex; the upper leaves are lanceolate, and basal leaves are often more ovate.

18. **Archidium** sp. **B**

Autoicous. Plants yellowish green, lax, to 20 mm tall, rarely branched. Stems in T.S. with epidermal cells 12–15 µm or more wide. Rhizoids of lower stem fine, forming a sparse whitish tomentum, those from base and in lower leaf axils pale brown, coarse, c. 20 µm wide. Leaves erect to erecto-patent, crowded and often falcate above, becoming shorter and more distant and spreading downwards, bract-like at base, amplexicaul, narrowly linear-lanceolate, finely acuminate, 1–2 mm long, 5–7 times longer than wide; margin scarcely or not recurved; costa usually excurrent in a long slender tapering flexuose sometimes spinulose arista in upper leaves, subpercurrent to percurrent in lower and innovation leaves, 50–120 µm wide, in T.S. crescent-shaped, 2 or 3 cells thick with 4–8 large adaxial cells; laminal cells narrowly prosenchymatous above, 50–80 × 5–6 µm, in mid-leaf thin-walled, in regular rows, rectangular to rhomboidal 50–100 × 9–12 µm, in alar region short-oblong, 12–20 µm wide in 3–5 rows, extending c. 7 cells up basal margin. Perichaetial and perigonial buds rare, lateral. Sporophyte not seen.

Known from raised mounds in coastal, swampy woodland in far north-eastern Qld. Map 55.

Qld: Eubenangee Swamp Natl Park, near Babinda, *I.G.Stone 24571* (MEL); Weipa, SE of Airport, June 1985, *M.Godwin* (MEL).

The long, finely tapering leaf apex with the costa excurrent in a slender arista separates this unnamed species from other Australian *Archidium* species. It resembles *A. longifolium* Lesq. & James [a growth form of *A. alternifolium* (Dicks. & Hedw.) Schimp. according to Snider (1975)], but differs in the wider costa and autoicous, not paroicous, sexual condition.

19. Archidium sp. C

Plants to 1.5 mm tall, yellowish green with a silky sheen. Stems in T.S. with 1 or 2 rows of large inner cortical cells and 1 or 2 outer rows of narrower firmer cells; innovations few, lateral, sometimes subperichaetial. Leaves comose in upper part of stems and innovations, loosely spreading to squarrose below, linear-lanceolate, 0.6–1.4 mm long, 0.16–0.18 mm wide, tapering to a deeply channelled flexuose subula; margin distantly serrulate, erect to incurved, rarely weakly recurved near insertion; costa usually percurrent, above almost filling the subula, in mid-leaf to 90 µm wide, at base more than half leaf width, in T.S. concave, 2 or 3 cells thick, with up to 12 large adaxial cells, abaxial cells numerous, much smaller, sometimes prorate; mid-leaf cells rectangular to prosenchymatous, often sinuose, 40–100 × 5–10 µm, often prorate, gradually shorter downwards; alar cells 12–30 × 10–12 µm; lamina 3–6 cells wide between costa and margin at base. Perigonia not seen. Perichaetia axillary, sessile or subsessile, sometimes clustered, rarely terminal on short branches. Perichaetial leaves concave, often secund, flexuose, sheathing, oblong-lanceolate, subulate, 0.65–1.30 mm long; margin incurved; costa usually percurrent, c. 55 µm wide in subula; laminal cells prosenchymatous to rhomboidal, in shoulder region 40–80 × 10–20 µm; marginal and subula cells narrower, prorate. Capsules not seen.

Locally common in coastal areas of north-eastern Qld between Cooktown and Cardwell; often found in dense mats on sandy banks near watercourses, in partial shade of mangroves or *Melaleuca*, binding soil by yearly increments. Map 56.

Qld: Massey Ck, Silver Plains, N of Cooktown, *J.R.Clarkson 2602* (BRI, MEL); Rowland property, Cooktown, *I.G.Stone 25467* (MEL); Dead Horse Ck, Cardwell, *I.G.Stone 22120* (MEL); Edmund Kennedy Natl Park, Cardwell, *I.G.Stone 25430* (MEL).

Archidium sp. C is characterised by a costa that occupies almost the entire leaf width throughout and an almost tubular subula. Plants superficially resemble *A. indicum* in the long, fine spreading leaves that are 5–7 times as long as wide, and the presence of brown rhizoidal gemmae, but the can be separated by the narrower laminal cells and broad costa. *Archidium* sp. C also differs from "sp. B" in the narrower laminal cells, and the costa that is never long-excurrent.

Excluded Names

Archidium brisbanicum Broth., *Oefvers. Förh. Finska Vetensk.-Soc.* 35: 35 (1893)

T: Ipswich Rd, Brisbane, Qld, 1890, *H.Tryon*; holo: H-BR.

This is *Eccremidium brisbanicum* (Broth.) I.G.Stone & G.A.M.Scott (*J. Bryol*. 7: 603, 1973; Ditrichaceae).

Archidium stolonaceum Müll.Hal., *Flora* 71: 8 (1888)

T: Paddington, Sydney, N.S.W., 1884, *T.Whitelegge*; lecto: MEL, *fide* J.A.Snider, *J. Hattori Bot. Lab*. 39: 154 (1975); isolecto: NSW.

This is *Eccremidium pulchellum* (Hook.f. & Wilson) Müll.Hal. (Ditrichaceae), *fide* I.G.Stone (*Muelleria* 2: 211, 1973).

Archidium ecklonii Hampe ex Müll.Hal., *Hedwigia* 38: 53 (1899)

T: Cape of Good Hope, South Africa, 1874, *F.C.Naumann*; lecto: BM, *fide* J.A.Snider, *J. Hattori Bot. Lab*. 39: 155 (1975); isolecto: FI.

Renamed *Pleuridium ecklonii* (Hampe ex Müll.Hal.) Snider (J.A.Snider, *loc. cit.*). While I agree with Magill (1981) that this placement is probably inappropriate, this is clearly not an *Archidium* as the type of branching is quite different.

SPLACHNOBRYACEAE

Bernard Goffinet[1]

Splachnobryaceae A.K.Kop., *Ann. Bot. Fenn.* 18: 128 (1981).

Type: *Splachnobryum* Müll.Hal.

Plants small, typically to 10 mm tall, green to orange below. Stems orthotropic, with a central strand surrounded by rather large parenchymatous cells with orange walls. Rhizoids smooth, sparse, at the base of the stem. Branching sparse, subapical and sympodial. Leaves ovate, lingulate, spathulate; apex rounded to acute; margin plane to slightly reflexed, entire below, crenulate to papillose above; costa single, weakly to strongly differentiated, ending in upper half of leaf to shortly below apex; laminal cells thin-walled, flat to slightly bulging; basal cells rectangular; upper cells short-rectangular to quadrate, hexagonal and nearly isodiametric, smooth or with 1 or 2 small conical papillae. Gemmae multicellular, infrequent. Sporophytes not seen.

The Splachnobryaceae comprises 15 species in three genera, *Koponobryum*, *Gymnostomiella* and *Splachnobryum*. These mosses occur mainly on calcareous clay or in rock crevices at subtropical and tropical latitudes. *Splachnobryum* and *Gymnostomiella* are known from Australia, each represented by one pantropical species.

The genera *Splachnobryum* and *Gymnostomiella* were considered by Brotherus (1924) to be members of the Splachnaceae, although sufficiently distinct to warrant accommodating them in a subfamily of their own, the Splachnobryoideae. Zander (1993) treated *Gymnostomiella* as a genus of the Pottiaceae. *Splachnobryum* was excluded from the Splachnaceae by Koponen (1981) and placed in the monotypic Splachnobryaceae. Recent molecular studies have confirmed that *Splachnobryum* is only distantly related to the Splachnaceae, having haplolepideous affinities (Goffinet & Cox, 2000), a hypothesis supported by the architecture of the peristome (Allen & Pursell, 2000).

V.F.Brotherus, Splachnaceae, *Nat. Pflanzenfam.*, 2nd edn, 10: 333–344 (1924); A.Koponen, Splachnobryaceae, a new moss family, *Ann. Bot. Fenn.* 18: 123–132 (1981); G.A.M.Scott, T.J.Entwisle, T.W.May & G.N.Stevens, *Conservation Overview of Australian Non-Marine Lichens, Bryophytes, Algae and Fungi*. Environment Australia, Canberra (1987); A.Stoneburner, R.Wyatt, D.G.Catcheside & I.G.Stone, Census of the mosses of Western Australia, *Bryologist* 96: 86–101 (1993); T.Arts, A revision of the moss genus *Gymnostomiella* Fleisch., *J. Bryol.* 20: 411–427 (1998); B.Allen & R.A.Pursell, A reconsideration of the systematic position of *Splachnobryum*, *J. Hattori Bot. Lab.* 88: 139–145 (2000); B.Goffinet & C.J.Cox, Phylogenetic relationships among basal-most arthrodontous mosses with special emphasis on the evolutionary significance of the Funariineae, *Bryologist* 103: 212–223 (2000); T.Arts, A revision of the Splachnobryaceae (Musci), *Lindbergia* 26: 77–96 (2001).

KEY TO GENERA

Upper laminal cells papillose; leaf margin papillose-crenulate................................ **1. GYMNOSTOMIELLA**
Upper laminal cells smooth; leaf margin entire to crenulate......................................**2. SPLACHNOBRYUM**

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1. GYMNOSTOMIELLA

Gymnostomiella M.Fleisch., *Musc. Buitenzorg* 1: 309 (1904); from the generic name *Gymnostomum*, and the suffix *-ella* (a diminutive), i.e. resembling a small *Gymnostomum*.

Type: *G. vernicosa* (Harv.) M.Fleisch.

Plants erect. Stems sparsely foliate, with a central strand. Leaves costate; basal laminal cells smooth, rectangular; upper cells papillose, irregularly isodiametric. Chromosome number not known.

Gymnostomiella was monographed by Arts (1998), who recognised five species and one variety. The genus is defined by small, slender plants bearing unicostate leaves with the upper cells ornamented by one or more small conical papillae. The latter character distinguishes the genus from *Splachnobryum*. All taxa grow on calcareous rocks.

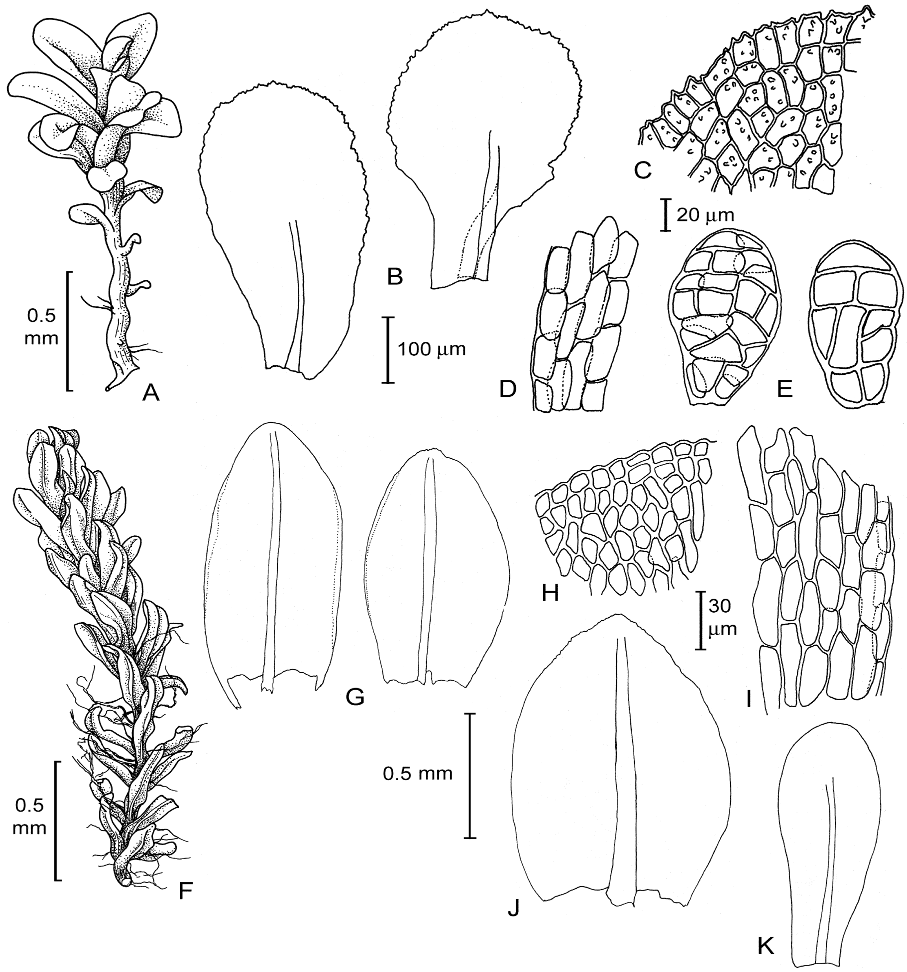

Figure 16. *Gymnostomiella* and *Splachnobryum*. **A–E**, *G. vernicosa*. **A**, Habit; **B**, Leaves; **C**, Upper laminal cells; **D**, Basal laminal cells; **E**, Gemmae (A, E, *Eurell 78/39*, CANB; B–D, *I.Stone 21740*, MEL). **F–K**, *S. obtusum*. **F**, Habit; **G**, Leaves; **H**, Upper laminal cells; **I**, Basal laminal cells (F–I, *F.M.Bailey*, CHR); **J**, Leaves (*H.Streimann* 48369, NY); **K**, Leaves (*H.Streimann 8829*, NY). Drawn by V.Kask.

Gymnostomiella vernicosa (Harv.) M.Fleisch., *Musc. Buitenzorg* 1: 310 (1904)

var. **vernicosa**

Gymnostomum vernicosum Harv., *in* J.D.Hooker, *Icon. Pl.* 1: 17, fig. 4 (1836); *Pottia vernicosa* (Harv.) Hampe, *in* C.Müller, *Syn. Musc. Frond.* 1: 557 (1849); *Hymenostylium vernicosum* (Harv.) Mitt., *Musc. Ind. Orient.* 33 (1859). T: Prome, Burma, 1826, *N.Wallich s.n.*; iso: E *n.v.*

Illustrations: P.L.Redfearn Jnr, *Bryologist* 94: 393, figs 1–27; 394, figs 28–31 (1991); R.H.Zander, *Bull. Buffalo Soc. Nat. Sci.* 32: 155, figs 1–4 (1993); T.Arts, *J. Bryol.* 20: 420, fig. 5; 422, fig. 6 (1998).

Plants to 2 mm tall, forming green tuffs. Stems with a central strand and orange somewhat incrassate parenchymatous cells. Leaves lingulate, with the apex much broader than the base, to 0.5 mm long and 0.25 mm wide; margin entire below, crenulate-papillose in upper half; costa ending in the middle or upper part of leaf; basal laminal cells, short- to long-rectangular, 27–60 × 12–15 µm; upper cells irregular in shape, 1–2 times longer than wide, 18–27 × 9–15 µm, mostly with (1–) 2 (–4) conical papillae. Gemmae green, multicellular, with transverse and longitudinal walls, axillary, to 100 µm long and 60 µm wide. Gametangia not seen. Fig. 16A–E.

Known from two localities in N.T. and eastern Qld; on calcareous sandstone. Also in the Neotropics, from Florida south to Brazil and in SE Asia. Map 57.

N.T.: Cave Beach, Cape Arnhem, S of Gove, *J. & J.Eurell 78/38*, *78/39* (CANB). Qld: Walkunder Tower, Chillagoe Natl Park, *I.G.Stone 21740* (MEL).

Only the type variety occurs in Australia; var. *tenerum* (Müll.Hal ex Dus.) Arts is broadly sympatric with var. *vernicosa* in the Americas and Asia, but unlike the latter it also occurs in Africa. It differs from the type variety in its unipapillose laminal cells.

The species has also been recorded from Western Australia (Scott *et al.*, 1987; Stoneburner *et al*., 1993), but the report could not be verified as no specimens were found in Australian herbaria, including the personal herbarium of the late Ilma Stone (N.Klazenga, pers. comm.).

2. SPLACHNOBRYUM

Splachnobryum Müll.Hal., *Verh. Zool.-Bot. Ges. Wien* 19: 503 (1869); from the generic names *Splachnum* and *Bryum*, in reference to the resemblance of *Splachnobryum* to these genera.

Type: *S. obtusum* (Brid.) Müll.Hal.

Plants erect. Stems with a central strand. Branching sparse, subapical and sympodial. Leaves costate; basal laminal cells, smooth, short to rectangular; upper cells smooth, quadrate to almost isodiametric. Chromosome number not known.

Arts (2001) monographed the Splachnobryaceae, tentatively retaining nine of the 56 described species and accommodating the Indian *S. bengalense* Gangulee in a new genus, *Koponobryum* Arts. *Splachnobryum* is characterised by small plants, with unicostate leaves and smooth laminal cells. Species grow on calcareous rocks, and the genus is represented in Australia by one species; an additional species, *S. crassinervium* Arts, is endemic to Norfolk Is. and is not treated here.

Splachnobryum obtusum (Brid.) Müll.Hal., *Verh. Zool.-Bot. Ges. Wien* 19: 504 (1869)

Weissia obtusa Brid., *Sp. Musc.* 1: 118 (1806). T: “In Hispanolia, Dominica aliisque Antillis terram habitantem primus”, *Poiteau*; iso: BM *n.v.*

Splachnobryum baileyi Broth., *Bot. Zentralbl.* 36: 85 (1888). T: “ubi ad Brisbane River”, Qld, *F.M.Bailey*; lecto: S, *fide* B.Goffinet, *Fl. Australia* 51: 410 (2006); isolecto: CHR.

Splachnobryum geheebii M.Fleisch., *Musc. Buitenzorg* 2: 472 (1904). T: Java, [Indonesia], *M.Fleischer 136*; holo: L *n.v.*

Illustrations: T.Arts, *J. Bryol.* 19: 72, fig. 4; 73, fig. 5 (1996); T.Arts, *Lindbergia* 26: 90, fig. 12; 91, figs 13 & 14; 92, fig. 15 (2001).

Plants to 10 mm tall. Rhizoids restricted to the base, pale brown, smooth. Stems with a central strand and yellowish somewhat incrassate parenchymatous cells. Branching sparse, subapical and sympodial. Leaves long-lingulate to broadly ovate, with a rounded or acute apex, somewhat keeled to concave, crisped when dry, with reflexed margins if leaves ovate, c. 1 mm long and 0.5 mm wide; margin entire, sometimes crenulate above; costa ending just below apex; basal laminal cells 15–48 × 12–18 µm; upper cells 10–15 µm long and wide, or rectangular to diamond-shaped with longest axis 15–30 µm long; marginal cells short and quadrate in upper half, elongate below. Archegonia typically single, axillary; paraphyses lacking. Perigonia not seen. Fig. 16F–K.

Rare in northern W.A., northern N.T. and eastern Qld; grows on shaded and semi-exposed soil and rock. A pantropical species. Map 58.

W.A.: Kununurra–Timber Creek hwy, 25 km SE of Kununurra, *H.Streimann 48369* (NY). N.T.: Fannie Bay, 4.5 km N of Darwin, *H.Streimann 8829* (CANB, NY); Pickertaramoor, Melville Is., *H.Streimann 42401* (CANB); East Alligator R., Kakadu Natl Park, *I.G.Stone 23344* (MEL); Berry Springs, *I.G.Stone 16230* (MEL).

The species is possibly more widespread in tropical Australia, but since it is not known to produce sporophytes here, it could be mistaken for sterile forms of various unrelated taxa such as *Bryum* spp. The few Australian collections exhibit much of the global morphological variation. The specimen collected at Fannie Bay, N.T. (*Streimann 8829*) was referred by its collector to *S. weimansii* M.Fleisch., a species endemic to Malesia (Arts, 2001). The similarities are indeed striking. These plants are also much taller and the leaves broader than in the other material considered here to be *S. obtusum* which, however, is variable in its leaf shape. *Streimann 8829* was ultimately assigned to *S. obtusum* due to the absence of clearly differentiated, basal marginal cells, and the shorter axillary hairs (Arts, 2001).

EPHEMERACEAE

Ilma G. Stone†

Ephemeraceae Schimp., *Coroll. Bryol. Eur.* 3 (1856).

Type: *Ephemerum* Hampe

Dioicous, autoicous, rhizautoicous or synoicous. Plants minute, terrestrial, ephemeral, scattered or gregarious, attached to a persistent protonema. Stem short, often reduced to a minute cluster of cells. Leaves in a rosette, few; outer ones bract-like; perichaetial leaves usually much longer, ovate to lanceolate or linear, with the apex acute to acuminate, sometimes awned; margin entire, serrate or ciliately dentate; costa often interrupted, sometimes absent, homogeneous in T.S.; laminal cells large, rectangular, rhomboidal to irregularly hexagonal, smooth, often prorate. Calyptra campanulate, sometimes cucullate; vaginula rounded, rarely elliptical. Setae very short or vestigial. Capsules subglobose to globose, short-apiculate, immersed; Australian representatives cleistocarpous with stomata in the basal part (*Ephemerum*), or stegocarpous with stomata below the dehiscence line (*Nanomitriopsis*). Spores large.

This family comprises three genera, two of which (*Ephemerum* and *Nanomitriopsis*) occur in Australia. The third, *Micromitrium* Austin, is characterised by a minute calyptra and a stegocarpous capsule lacking stomata.

I.G.Stone, A revision of Ephemeraceae in Australia, *J. Bryol.* 19: 279–295 (1996).

KEY TO GENERA

Capsule cleistocarpous; plants dioicous or rhizautoicous .... **1. EPHEMERUM**

Capsule with a line of dehiscence; plants synoicous or paroicous .... **2. NANOMITRIOPSIS**

1. EPHEMERUM

Ephemerum Hampe, *Flora* 20: 285 (1837), *nom. cons.*; the name refers to the ephemeral habit of these mosses.

Lecto: *E. serratum* (Hedw.) Hampe

Dioicous or rhizautoicous. Plants 0.5–2.5 mm tall, acaulescent or almost so, with a conspicuous protonema. Leaves 2–12, the outer bract-like, oval to narrowly lanceolate, the inner perichaetial leaves linear, lanceolate, spathulate or ligulate, acute to finely acuminate; costa absent, rudimentary or more well developed, sometimes excurrent in an awn, usually absent towards the leaf basal. Perigonia gemma-like, on rhizoids, often with associated the protonema. Calyptra campanulate, papillose or smooth, with 1–4 splits at the base, sometimes cucullate; vaginula subglobose, rarely ellipsoidal. Capsules cleistocarpous, ±globose, rarely ellipsoidal; stomata present at base. Spores usually papillose.

A genus of about 30 species which is widely distributed in temperate regions of both hemispheres. Represented in Australia by six species, two of which are endemic.

The protonema is often more conspicuous than the gametophores, and the vegetative leaves are usually much smaller than the perichaetial leaves. While the latter is the most useful diagnostic feature, perichaetial leaves do not enlarge until after fertilisation. As a result, immature plants can be difficult to determine. The calyptra cells can be tumid at first, but they later collapse and appear ±smooth.

G.Roth, *Aussereur. Laubm.* 1: 227–243 (1911); R.E.Magill, *Fl. Southern Africa: Bryophyta* 1(2): 1–443 (1987).

1 Leaves lanceolate-subulate, costate; margin entire, serrate or denticulate; calyptra usually cucullate; vaginula ellipsoidal or cylindrical 2

1: Leaves variously shaped; costa absent or rudimentary; margin dentate, sometimes deeply incised; calyptra usually campanulate; vaginula subglobose 3

2 Perigonia lacking paraphyses; spores 20–30 µm diam.; leaf margin entire to serrate *(1)* ....**6. E. rehmannii**

2: Perigonia with uniseriate filamentous paraphyses mixed with antheridia; spores 25–40 µm diam.; leaf margin serrate to denticulate .... **5. E. recurvifolium**

3 Perichaetial leaves mostly less than 1 mm long, narrowly linear or lanceolate, ecostate; margin with simple distant teeth; gametophores ±hidden by protonema *(1:)* 4

3: Perichaetial leaves mostly 1.0–2.5 mm long, variously shaped, spathulate or oblong to ligulate; costa rudimentary; margin with very large simple or branched teeth appearing ciliate or laciniate; mature gametophores usually clearly visible above protonema 5

4 Mature gametophores minute, completely hidden by protonema; leaves 1–3; leaf apices entire *(3)*..... ....**1. E. capense**

4: Mature gametophores showing above protonema; leaves 3–6, bifurcated at apex into 2 filamentous toothed or entire prongs .... **4. E. furcatum**

5 Perichaetial leaves narrow, ligulate; margin fringed with short and long thorn-like often recurved teeth; bistratose costa almost as wide as lamina; calyptra cells tuberculate *(3:)*.....................**3. E. fimbriatum**

5: Perichaetial leaves narrowly oblong, lanceolate or spathulate; margin fringed with sharp or rounded teeth and laciniae composed of large compound antler-like teeth; bistratose costal region narrow in proportion to total width of lamina; calyptra cells tumid or smooth ....**2. E. cristatum**

1. Ephemerum capense Müll.Hal., *Flora* 71: 12 (1888)

T: Somerset East, Boschberg, Cape of Good Hope, South Africa, 1882, *Prof. Macowan*; holo: *n.v.*

Illustrations: G.Roth, *Aussereur. Laubm.* 1: pl. 24, fig. 66 (1911); R.E.Magill, *Fl. Southern Africa: Bryophyta* 1(1): fig. 86 (9–16) (1981); I.G.Stone, *J. Bryol.* 19: 286, fig. 4 (1996).

Rhizautoicous. Plants acaulescent, completely obscured by the pale green 2.0–2.5 mm high protonema. Leaves, including perichaetial leaves, only 2 or 3, ±uniform, linear to linear-lanceolate, to c. 0.6 mm long and 0.1 mm wide, ecostate; margin toothed above, entire to serrulate below; laminal cells ±rectangular, 50–120 × 15–20 µm. Perigonia usually with a single bract enclosing 1 antheridium. Calyptra campanulate, usually smooth; vaginula subglobose. Capsules c. 400 µm diam. Spores ±globose, 40–60 µm diam., brown.

Occurs in eastern Qld on moist earth banks; also in Africa. Map 59.

Qld: Cania Gorge Natl Park, near Monto, *I.G.Stone 20979* (MEL); Enoggera Ck, Brisbane, *I.G.Stone 4733* (MEL).

This species is readily recognised by the almost leafless plants completely enveloped in a much taller, copious protonema that is loose, cobwebby and not fastigiate as in *E. fimbriatum*.

2. Ephemerum cristatum (Hook.f. & Wilson) Müll.Hal., *Bot. Zeitung (Berlin)* 5: 101 (1847)

Phascum cristatum Hook.f. & Wilson, *in* J.D.Hooker, *Icon. Pl. Rar.* 8: 737A (1845). T: Swan River, W.A., *J.Drummond*; lecto: BM, *fide* I.G.Stone, *J. Bryol.* 19: 283 (1996); isolecto: BM.

Ephemerum grosseciliatum Müll.Hal., *Hedwigia* 37: 77 (1898). T: near Melbourne, Vic., 5 July 1884; *F.M.Reader*; lecto: MEL, *fide* I.G.Stone, *J. Bryol.* 19: 283 (1996).

Illustrations: G.A.M.Scott & I.G.Stone, *The Mosses of Southern Australia* 266, pl. 49 (1976); D.G.Catcheside, *Mosses of South Australia* 240, fig. 137 (1980); I.G.Stone, *J. Bryol.* 19: 282, fig. 1; 283, fig. 2 (1996).

Plants pale green to golden-green, scattered or gregarious on an extensive pale green protonema. Leaves 6–10, the perichaetial leaves spathulate, narrowly lanceolate or oblong, 1.0–1.5 mm long, 0.2–0.4 mm wide, often cristate on distal abaxial surface; apex obtuse-mucronate, acute or acuminate; margin above mid-leaf deeply laciniate, dentate-ciliate with sharp or rounded teeth; costa rudimentary, usually 2 or 3 cells wide, failing below apex or excurrent in a long awn, absent below; laminal cells rectangular to rhomboidal, smooth or prorate, firm to thick-walled, 30–200 × 12–25 µm. Calyptra campanulate; cells smooth or tumid. Capsules bright or rusty red. Spores globose or reniform, 40–90 µm, reddish brown.

Endemic to Australia and occurring in all States and Territories except A.C.T.; widespread except in montane areas and the far north; grows on damp earth along watercourses or in protected gorges in desert areas. Map 60.

W.A.: 6.5 km W of Hopetoun, *A.C.Beauglehole 14723* (MEL). N.T.: Rabbit Flat, Tanami Track, *I.G.Stone 16220* (MEL). S.A.: N of Donovans Landing, *A.C.Beauglehole 16230* (MEL). Qld: Coominglah, *I.G.Stone 21134* (MEL). N.S.W.: 44 km S of Dubbo, *I.G.Stone 4645* (MEL). Vic.: Whipstick area, Bendigo, *I.G.Stone 398* (MEL). Tas.: Brooks Field, *R.A.Bastow* (MEL).

Distinguished from *E. fimbriatum* by the marginal laciniae composed of compound, antler-like teeth and the narrow, rudimentary costa usually with numerous abaxial spines in the upper half of the leaf.

3. **Ephemerum fimbriatum** Müll.Hal., *Linnaea* 37: 145 (1872)

T: Brisbane River, Qld, 1864, *A.Dietrich*; iso: BM.

Illustrations: G.Roth, *Aussereur. Laubm.* 1: pl. 24, fig. 11 (1911); *I.G.Stone*, *J. Bryol.* 19: 285, fig. 3 (1996).

Plants acaulescent; protonema fastigiate, almost as tall or taller than gametophore. Leaves 5–8, narrowly ligulate, the perichaetial leaves up to 1.8 mm long and 0.15 mm wide, tapering to a long toothed awn; margin fringed with short and long thorn-like, sometimes compound, often recurved teeth to 100 µm long; costa rudimentary, bistratose or occasionally tristratose, almost as wide as lamina, absent below; laminal cells ±rectangular, 80–100 × 15–30 µm. Cells of calyptra usually tuberculate; vaginula subglobose. Capsules 450–500 µm diam. Spores usually 35–80 µm.

Occurs in north-western W.A., the central gorges of the N.T. and in eastern Qld; grows on damp, shaded earth. Also in New Caledonia. Map 61.

W.A.: Yannarie R., 149 km S of Onslow, *A.C.Beauglehole 14030* (MEL). N.T.: Ayers Rock [Uluru Natl Park], *A.C.Beauglehole 22892* (MEL). Qld: Burpengary, 1888, *C.J.Wild* (MEL); The Gap, Enoggera Ck, Brisbane, *S.T.Blake 22984* (BRI); Meunga Ck, Galmara, Cardwell, *I.G.Stone 21995* (MEL).

Mature plants are distinguished from other species of *Ephemerum* by the very long, narrow, mostly bistratose leaves, and the leaf margins with sharp, often recurved teeth and few laciniae.

4. **Ephemerum furcatum** I.G.Stone, *J. Bryol.* 19: 287 (1996)

T: Cane River area, SE of Onslow, W.A., 18 Aug. 1965, *A.C.Beauglehole 14025*; holo: MEL.

Illustration: I.G.Stone, *op. cit*. 288, fig. 5.

Plants acaulescent, c. 1 mm tall, with protonema reaching three-quarters the height of the mature gametophore. Leaves 3–6, 0.4–1.0 mm tall, the perichaetial leaves linear, ecostate; apex usually split into 2 filamentous toothed or entire parts; margin with irregular distant teeth; laminal cells ±rectangular, 80–150 × 20–30 µm in mid-leaf, narrower above. Perigonia c. 300 µm long. Calyptra campanulate, c. 200 µm, split at the base; vaginula dark, subglobose. Capsules subsessile, subglobose to ±globose, apiculate, c. 650 × 450–550 µm. Mature spores not seen.

Endemic to W.A., and so far known only from the type locality. Map 62.

Readily distinguished from other species by the bifurcated leaf apices.

5. **Ephemerum recurvifolium** (Dicks.) Boulay, *Fl. Crypt. Est. Musc.* 694 (1872)

Phascum recurvifolium Dicks., *Pl. Crypt. Britt.* 4: 1 (1801). T: near Croydon, England, *J.Dickson*; lecto: BM, *fide* I.G.Stone, *J. Bryol.* 19: 290 (1996).

Illustrations: A.J.E.Smith, *Moss Flora of Britain and Ireland* 288, fig. 164 (7–9) (1978); I.G.Stone, *J. Bryol.* 19: 291, fig. 7 (1996).

Plants usually similar to those of *E. rehmannii* (see below). Leaf margin serrate to denticulate, sometimes with 1 or 2 larger teeth at base of awn; costa often more robust, 25–40 µm wide, sometimes rough abaxially, short- or long-excurrent, 3–5 cells thick;

laminal cells 30–100 × c. 12–15 µm; basal cells to 20 µm wide. Perigonia with up to 6 leaves and c. 6 antheridia, interspersed with filamentous paraphyses. Calyptra cucullate; vaginula cylindrical, c. 300 µm long, often reddish brown throughout. Capsules ovoid, with a short oblique apiculus. Spores (25–) 30–40 µm diam., golden, granulose, papillose.

Occurs on soil crust with algae, lichens and other bryophytes in roadside claypans between Wentworth and Broken Hill in south-western N.S.W.; also in Europe, Russia and North Africa. Map 63.

N.S.W.: Silver City Hwy, S of Broken Hill, 214 km N of Wentworth, *I.G.Stone 9582* (BM, MEL); *loc. id.*, *I.G.Stone 11510* (MEL).

6. Ephemerum rehmannii (Müll.Hal.) Broth., *Nat. Pflanzenfam*., 2nd edn, 10: 319 (1924)

Ephemerella rehmannii Müll.Hal., *Flora* 71: 12 (1888). T: Bloemfontein, Orange Free State, South Africa, 1875, *Rehmann*; holo: G *n.v*.

Illustrations: G.Roth, *Aussereur. Laubm.* 1: pl. 22, fig. 11 (1911), as *Ephemerella rehmannii*; R.E.Magill, *Fl. Southern Africa: Bryophyta* 1(1): fig. 86 (17–23) (1981); I.G.Stone, *J. Bryol.* 19: 289, fig. 6 (1996).

Plants to 2.8 mm tall. Leaves 6–10, the perichaetial leaves erect, recurved or twisted, narrowly lanceolate, 0.5–2.5 mm long; apex acuminate, sometimes awned; margin usually bluntly toothed above, entire to distantly serrulate below; costa long-excurrent or subpercurrent, 20–35 µm wide, sometimes rough abaxially, 3 or 4 cells thick; laminal cells rectangular, linear-rhomboidal or prosenchymatous, 25–100 × 8–15 µm, shorter above, often narrower at margin. Perigonia bud-like; leaves and antheridia 2–4; paraphyses lacking. Calyptra smooth, cucullate with 1 or 2 splits, 450–550 µm long; vaginula narrowly ellipsoidal, c. 250 µm long, coloured around rim. Capsules often ellipsoidal, 500–600 µm long. Spores 20–30 µm diam., sharply papillose, pale brown.

Widespread but sporadic; occurs in W.A from the Shark Bay area to Feysville, probably in S.A and southern Qld (specimens very immature), in N.S.W. and in northern Vic. Also in southern Africa. Map 64.

W.A.: Shark Bay, *I.G.Stone 8018* (MEL); Murchison Gorge, *I.G.Stone 6151 p.p.* (MEL). N.S.W.: Willow Tree Ck, Limestones via Attunga, 9 Sept. 1991, *A.Downing* (CANB). Vic.: Boundary Bend, *I.G.Stone 1384* (MEL); Copi Plain, S of Wyperfeld, *G.A.M.Scott* (MEL).

The protonema is less obvious than in other Australian species; it forms a small tuft often infiltrated with soil at the base of male and female plants. *Ephemerum rehmannii* resembles the less common *E. recurvifolium*, but it usually differs in the narrower leaf cells, perigonia lacking paraphyses and smaller spores with minute, sharp papillae.

2. NANOMITRIOPSIS

Nanomitriopsis Cardot, *Rev. Bryol*. 36: 18 (1909); from the Greek suffix -*opsis* (-like), in reference to the similarity in appearance to the genus *Nanomitriella* E.B.Bartram.

Type: *N. longifolia* Cardot

Synoicous or paroicous. Plants gregarious, simple or with a basal branch. Protonema sparse, web-like, pale green. Leaves linear-lanceolate, acuminate; margin crenulate above, entire below; costa absent or rudimentary; laminal cells large, thin-walled, chlorophyllose, prosenchymatous, linear-rhomboidal to rectangular, shorter near apex. Calyptra campanulate, reaching almost to the dehiscence line; vaginula cup-shaped. Setae reduced; foot subglobose. Capsules sessile, immersed, stegocarpous, globose or subglobose; stomata phaneropore, few, just below the line of dehiscence; operculum short-apiculate.

This monotypic genus occurs in Australia and Central Africa.

Nanomitriopsis resembles *Ephemerum* except for the arrangement of antheridia and the line of dehiscence in the capsule.

Nanomitriopsis longifolia Cardot, *Rev. Bryol*. 36: 18 (1909)

Bruchia longifolia (Cardot) G.Roth., *Aussereur. Laubm.* 1: 121 (1911); *Sporledera longifolia* (Cardot) Broth., *Nat. Pflanzenfam.*, 2nd edn, 10: 158 (1924). T: Kisantu, Belgian Congo [Democratic Republic of Congo], 1906, *H.Vanderyst*; holo: PC *n.v.*

Illustrations: Z.Iwatsuki, *Misc. Bryol. Lichenol.* 8: 132, fig. 3 (1980); I.G.Stone, *J. Bryol.* 19: 294, fig. 8 (1996).

Plants soft, to 1.5 mm tall, pale green. Leaves 6–10, the perichaetial leaves to 1.3 mm long; laminal cells lax, thin-walled, chlorophyllose, shorter near apex, c. 50 µm long, longer in mid-leaf, 100–150 × 15–25 µm. Spores 50–65 µm diam. (not seen in Australian specimen).

Collected once in W.A. on damp earth in arid zone with intermittent rainfall. Also in Central Africa. Map 65.

W.A.: Kangaroo Pool, Napier Ra., 3 May 1988, *B.Spooner* (MEL).

Excluded Names

Ephemerum whiteleggei Broth. & Geh., *Oefvers. Förh. Finska Vetensk.-Soc.* 37: 156 (1895)

T: North Shore and Balls Head Bay, Sydney, N.S.W., *T.Whitelegge 45* & *221*; syn: H-BR, MEL, NSW.

This is *Eccremidium minutum* (Mitt.) I.G.Stone & G.A.M.Scott (Ditrichaceae).

Micromitrium brisbanicum (Broth.) Crosby, *Bryologist* 71: 115 (1968)

T: Ipswich Rd, near Brisbane, Qld, 1890, *H.Tryon*; syn: BRI, H-BR, MEL.

This is *Eccremidium brisbanicum* (Broth.) I.G.Stone & G.A.M.Scott (Ditrichaceae).

ERPODIACEAE

Ilma G. Stone†

Erpodiaceae Broth., *Nat. Pflanzenfam.* I, 3: 706 (1905).

Type: *Erpodium* (Brid.) Müll.Hal.

Autoicous. Plants creeping, forming loose or dense mats, irregularly to pinnately branched. Stems soft, terete or complanate; branches short, horizontal or semi-erect. Rhizoids smooth, clustered on underside of stems. Leaves glaucous or yellowish to brownish green, either dimorphic and 4-ranked, with 2 dorsal rows subdistichous and covering the 2 smaller ventral rows (amphigastria-like), or ±uniform, densely inserted, erect-appressed when dry, sometimes loosely complanate when moist, occasionally secund, symmetrical or asymmetrical, oblong-lanceolate to oblong-ovate or elliptic, ecostate; apex rounded, obtuse, acute or acuminate, occasionally hairpointed; margin ±entire; laminal cells hexagonal, quadrate or subquadrate, often oblate (especially at margins and basal angles), smooth or sometimes with a weak abaxial mammilla, with a primordial utricle, or pluripapillose. Gametoecia terminal on short branches, or axillary. Perichaetial leaves usually erect, ±sheathing. Calyptra scarcely covering the operculum or reaching to ±mid-capsule, usually plicate, mitrate to cylindrical, rarely cucullate. Setae short, ±straight; vaginula usually long. Capsules immersed to short-exserted, erect, symmetrical, ovoid to cylindrical; annulus usually persistent; operculum conical-apiculate to rostrate; stomata usually few. Peristome often lacking, if present either rudimentary or consisting of 16 lanceolate papillose teeth. Spores globose, 25–45 µm diam., finely papillose, green.

A monotypic family of c. 24 species, comparatively rare but widely distributed and sometimes locally abundant; grows on bark and rock in tropical and subtropical regions, especially Africa, Australia and Central and South America. It is represented in Australia by six species and an additional variety; two species and a variety are endemic. The more mesophytic species occur in coastal rainforest and inland, monsoonal, gallery forest, the more xerophytic in drier, inland, deciduous vine thickets and *Eucalyptus* woodland.

In his worldwide review of the family Crum (1973) recognised five genera: *Erpodium*, *Aulacopilum*, *Wildia* and the extra-Australian *Venturiella* and *Microtheciella*. *Microtheciella* was subsequently accommodated in a family of its own (H.A.Miller & A.J.Harrington, *J. Bryol.* 9: 519–524, 1977). Stone (1997), in a detailed study of Australian species of *Erpodium*, *Aulacopilum* and *Wildia*, placed *Aulacopilum*, *Venturiella* and *Wildia* in the synonymy of *Erpodium*, thus rendering the Erpodiaceae monotypic.

V.F.Brotherus, Erpodiaceae, *Nat. Pflanzenfam.*, 2nd edn, 11: 1–6 (1925); H.A.Crum, A taxonomic account of the Erpodiaceae, *Nova Hedwigia* 23: 201–224 (1973); R.A.Pursell, *Moss Fl. Mexico* 2: 581–588 (1994); I.G.Stone, A revision of Erpodiaceae with particular reference to Australian taxa, *J. Bryol.* 19: 485–502 (1997).

ERPODIUM

Erpodium (Brid.) Müll.Hal., *Bot. Zeitung (Berlin)* 1: 774 (1843); from the Greek *erpo* (creeping), in reference to the creeping habit of these mosses.

Type: *E. domingense* (Spreng.) Brid. ex Müll.Hal.

Anoectangium [subg.] *Erpodium* Brid., *Bryol. Univ.* 2: 167 (1827). T: *A. domingense* Spreng. [= *Erpodium domingense* (Spreng.) Brid. ex Müll.Hal.].

Aulacopilum Wilson, *London J. Bot.* 7: 90 (1848). T: *A. glaucum* Wilson [= *Erpodium glaucum* (Wilson) I.G.Stone].

Wildia Müll.Hal. & Broth., *Oefvers. Förh. Finska Vetensk.-Soc.* 33: 103 (1891). T: *W. solmsiellacea* Müll.Hal. & Broth. [= *Erpodium solmsiellaceum* (Müll.Hal. & Broth.) I.G.Stone].

Description as for the family.

1 Leaves dimorphic, in 4 rows, the leaves in the 2 dorsolateral rows larger; plants complanate................2

1: Leaves uniform, densely arranged around the stem; plants terete-foliate or sometimes loosely complanate 4

2 Dorsal leaves obliquely ovate; apex acute or with a hyaline apiculus; ventral leaves slightly smaller, more symmetrical; apex acuminate, sometimes with a clear apical cell *(1)*...................**4. E. glaucum**

2: Dorsal leaves orbicular; apex rounded; ventral leaves smaller and narrower....................................3

3 Papillae on laminal cells of dorsal leaves distinctly compound, hollow, large, often C- to O-shaped; on ventral leaves different, mostly simpler, solid, smaller; peristome well developed; calyptra mitrate, plicate *(2:)*..**6. E. solmsiellaceum**

3: Papillae on laminal cells similar on dorsal and ventral leaves, mostly solid, simple, some bifid or trifid; peristome absent; calyptra cucullate, not plicate ....**2. E. biseriatum**

4 Laminal cells pluripapillose *(1:)* ....**1. E. beccarii**

4: Laminal cells smooth (distal cells occasionally with a single weak mammilla on abaxial surface) 5

5 Mid-laminal cells mostly oblate; rhizoids usually white; calyptra short, just covering the operculum *(4:)* ....**3. E. coronatum** var. **australiense**

5: Mid-laminal cells mostly rhomboidal, longer than wide; rhizoids pale brown; calyptra long, reaching beyond the base of the capsule .... **5. E. hodgkinsoniae**

1. **Erpodium beccarii** Müll.Hal. ex Venturi, *Nuovo Giorn. Bot. Ital.* 4: 18 (1872)

T: Abyssinia [Ethiopia], *O.Beccari*; holo: NY *n.v.*

Stems 10–20 mm long; branches horizontal, terete-foliate when dry. Leaves green to yellowish brown, erect-appressed when dry, spreading and loosely complanate when moist, subsymmetrical, concave-ovate to elliptic, 0.6–0.9 mm long, c. 0.4 mm wide; apex acute to acuminate or obtuse; hairpoint hyaline, distantly serrulate, broad at base with cells weakly papillose, often squarrose, 0.2–0.5 mm long; laminal cells bulging, hexagonal to ±isodiametric, c. 15 µm diam., pluripapillose; papillae simple or bifurcated, verrucose, very prominent, 3–5 per cell; alar cells oblate-hexagonal, pale, ±smooth.

Occurs in Africa, North and South America and Australia. There are two varieties.

Capsules ±sessile, immersed; calyptra mitrate, plicate, not reaching the base of capsule, less than 1 mm long; leaf hairpoints white, 0.25–0.50 mm long... **1a.** var. **beccarii**

Capsules emergent; seta short; calyptra mitrate, plicate, twisted, reaching the base of capsule or below, 2.5–3.0 mm long; leaf hairpoints pale yellowish, 0.20–0.35 mm long .... **1b.** var. **longicalyptratum**

1a. **Erpodium beccarii** Müll.Hal. ex Venturi var. **beccarii**

Illustrations: V.F.Brotherus, *Nat. Pflanzenfam.*, 2nd edn, 11: 2, fig. 421K, L (1925), as *E. joannis-meyeri* Müll.Hal.; T.R.Sim, *Bryophyta of South Africa* 347 (1926), as *E. hanningtonii* Mitt.; I.G.Stone, *J. Bryol.* 19: 495, fig. 3a–e (1997).

Leaves deep green, with a white hairpoint 0.25–0.50 mm long. Perichaetia not seen in Australian material. Calyptra (in extra-Australian material) campanulate-mitrate, plicate, serrate on ribs, lobed at base, less than 1 mm long. Capsules immersed; annulus broad, 5–6-rowed. Peristome lacking.

Very rare in Australia, and recorded only from west of Mackay, Qld where it grows in monsoon forest on a vertical sandstone rockface. Also in Central and South America and Africa. Map 66.

Qld: L. Elphinstone, W of Mackay, 54 km NNE of Moranbah, *R.J.Fensham 46* (CANB).

Although there is some doubt regarding its identity, the Queensland record has been retained here as the leaves are a deeper green with a longer, strongly contrasting, white hairpoint.

1b. **Erpodium beccarii** var. **longicalyptratum** I.G.Stone, *J. Bryol.* 19: 495 (1997)

T: Mickeys Ck, Carnarvon Gorge Natl Park, Qld, 27 Aug. 1982, *I.G.Stone 20430*; holo: MEL.

Illustrations: I.G.Stone, *op. cit.* 498, figs 5a–j, 6m (1997).

Plants glaucous green. Stems subterete, 10–30 mm long. Rhizoids pale red-brown. Leaves appressed when dry, loosely complanate when moist, ±uniform, 0.75–1.00 mm long, mostly broadly elliptic; apex acute to acuminate; hairpoint hyaline or yellowish, 0.20–0.35 mm long; laminal cells 5–6-sided, ±isodiametric, 12.5–16.0 µm diam., pluripapillose; papillae warty, 2–5 per cell. Perichaetia on decumbent branches, 1.5–2.0 mm long; perichaetial leaves to 3 mm long (including long hairpoint). Calyptra mitrate, plicate, 2.5–3.0 mm long, ridged, twisted, with 1–8 splits, persistent; basal lobes clasping seta. Setae 0.6–1.0 mm long. Capsules emergent, ±cylindrical, contracted to the mouth, 1.5–1.9 mm long; annulus consisting of 6–8 cell rows; operculum 0.4–0.5 mm. Spores 20–30 µm diam.

Endemic to southern Qld; rare on rough bark of *Casuarina*. Map 67.

Qld: type locality, *I.G.Stone 20420, 20459* (MEL); near Angiopteris Ravine, Carnarvon Gorge Natl Park, *I.G.Stone 20250* (MEL).

Erpodium beccarii var. *longicalyptratum* differs from *E. hodgkinsoniae* in having pluripapillose laminal cells. Vegetatively it is almost indistinguishable from var. *beccarii*, although the leaves of the latter are a darker green to yellowish green, and most have a longer, contrasting, white hairpoint. The calyptra and sporophyte, however, are significantly different, and this might warrant recognition as a distinct species.

2. **Erpodium biseriatum** (Austin) Austin, *Bot. Gaz. (Crawfordsville)* 2: 142 (1877)

Lejeunea biseriata Austin, *Proc. Acad. Nat. Sci. Philadelphia* 21: 225 (‘1869’) [1870]. T: near Augusta, Georgia, U.S.A., 1845, *W.S.Sullivant*; holo: NY *n.v.*

Illustrations: V.F.Brotherus, *Nat. Pflanzenfam.*, 2nd edn, 11: 6, fig. 424H–L (1925), as *Solmsiella paraguensis* Broth.; Z.Iwatsuki & A.J.Sharp, *J. Hattori Bot. Lab.* 30: 162, fig. 7 (1967), as *Solmsiella biseriata*; I.G.Stone, *J. Bryol.* 19: 490, fig. 1k–n (1997).

Branches flattened. Leaves strongly complanate, dimorphic, 4-ranked; dorsolateral leaves asymmetrical, oblong-orbicular, c. 0.5 mm long and 0.3 mm wide; ventral leaves ±lingulate, rounded-obtuse, c. 0.35 mm long and 0.15 mm wide; mid-laminal cells mostly 5–6-sided, near margin quadrate to oblate for a few rows, in dorsolateral leaves c. 15–24 × 10–14 µm, in ventral leaves 15–20 × 8 µm, pluripapillose; papillae solid, simple, bifid or trifid, similar on dorsal and ventral leaves. Calyptra cucullate, non-plicate, c. 0.5 mm long, not reaching below mid-capsule. Setae c. 0.6–0.8 mm long. Capsules exserted; theca oblong, 0.55–0.85 mm long; annulus consisting of a single row of cells. Peristome lacking. Spores c. 21–31 µm diam.

Rare in Australia and found as an epiphyte in a sheltered ravine in evergreen monsoon forest in northern N.T. and on the bark and fine roots of a large strangler fig in north-eastern N.S.W. Widespread in the tropics; known from U.S.A., Mexico, the Caribbean, South America, Africa, India, Thailand, Taiwan, the Philippines and Java. Map 68.

N.T.: Nourlangie, Kakadu Natl Park, *J.Russell-Smith 106* (CANB). N.S.W.: Victoria Forest Reserve, Lismore, *D.H.Vitt 28255* (ALTA).

This species closely resembles *E. solmsiellaceum* in its vegetative characters, but the ventral leaves are more lingulate, and the laminal cells differ in having solid, undivided papillae on both the dorsal and ventral leaves. The cucullate, weakly papillose, non-plicate calyptra is also diagnostic.

3. **Erpodium coronatum** (Hook. & Wilson) Mitt., *J. Linn. Soc., Bot.* 12: 403 (1869)

var. **australiense** (I.G.Stone) I.G.Stone, *J. Bryol.* 19: 488 (1997)

Erpodium australiense I.G.Stone, *J. Bryol.* 12: 191 (1982). T: Mungana, near Chillagoe, Qld, 19 Aug. 1979, *I.G.Stone 15928*; holo: BRI; iso: MEL.

Illustrations: I.G.Stone, *J. Bryol.* 12: 193, fig. 1a–j; 194, fig. 2a–k; pl. 1 (1982), as *E. australiense*; I.G.Stone, *J. Bryol.* 19: 495, fig. 3f–l (1997).

Stems terete-foliate, often secund where rooting; branches very short, horizontal or semi-erect. Rhizoids white. Leaves ±uniform, erect-appressed when dry, patent when moist, hyaline-awned, symmetrical or subsymmetrical, ovate to oblong-lanceolate, 0.8–1.0 mm long, 0.25–0.45 mm wide; laminal cells smooth (occasionally with a single abaxial mammilla),

bulging, hexagonal or rounded, in mid-leaf oblate, c. 20 × 30 µm. Perichaetial leaves transparent, appressed to capsule, 1.4–1.7 mm long, 0.65–0.80 mm wide, ending in a long twisted squarrose hyaline hairpoint. Calyptra mitrate, with serrate crests on ridges, c. 0.5 mm long, barely covering the operculum. Setae extremely short or absent. Capsules immersed to sessile, pale, decumbent when dry, suberect when moist; theca ovoid-cylindrical, c. 1.0–1.2 mm long, 0.75–0.80 mm wide; operculum 0.25–0.30 mm long. Peristome rudimentary, white; teeth papillose, c. 200 µm long. Spores 40–45 µm diam.

Endemic to north-western W.A., N.T and Qld; grows appressed to the bark of trees, usually in rather dry, semideciduous, monsoon forest, in sheltered gorges or in *Eucalyptus* woodland. Map 69.

W.A.: Wonjarring Gorge, Carson Escarpment, 35 km E of New Theda HS, *G.Butler 144A* (CANB); Winjana Gorge, Lennard R., Napier Ra., West Kimberley, 25 July 1974, *J.H.Willis* (MEL). N.T.: 18 km ENE of Jabiru, Arnhem Land, *H.Streimann 42222* & *J.A.Curnow* (B, CANB, NAM, NY). Qld: Lawn Hill Gorge Natl Park, *I.G.Stone 23278* (MEL); junction of Burke Rd and Blackdowns Rd, *H.Streimann 46456* (CANB, COLO, KRAM, MO, NY, PRE, S).

This variety differs from the widespread, extra-Australian var. *coronatum* mainly in the long-awned, vegetative and perichaetial leaves (sometimes appearing almost hoary when dry) and much smaller leaves, laminal cells, capsules and calyptra. The gametophore closely resembles that of *E. hodgkinsoniae*.

4. **Erpodium glaucum** (Wilson) I.G.Stone, *J. Bryol.* 19: 487 (1997)

var. **glaucum**

Aulacopilum glaucum Wilson, *London J. Bot.* 7: 90 (1848). T: New Zealand, 1843, *W.Colenso 3668a*; lecto: BM, *fide* I.G.Stone, *loc. cit*.; isolecto: BM.

Illustrations: G.O.K.Sainsbury, *Bull. Roy. Soc. New Zealand* 5: 194, fig. 2 (1955); I.G.Stone, *J. Bryol*. 19: 493, figs 2a–g, 5 (1997).

Plants slender, glaucous green. Stems to 10 mm long. Rhizoids red-brown. Leaves erecto-patent and loosely complanate when moist, appressed and overlapping when dry, dimorphic, 4-ranked; dorsolateral leaves asymmmetrically ovate, 0.35–0.70 mm long, 0.25–0.35 mm wide; apex acute, with or without a clear papillose uniseriate apiculus; ventral leaves smaller, lanceolate, sometimes with an acuminate apical cell; laminal cells pluripapillose, rounded-hexagonal or quadrangular, c. 12–15 µm diam., in mid-leaf c. 25 µm long, near margins more isodiametric, at basal angles somewhat oblate. Perichaetial leaves c. 0.6–0.9 mm long, broadly ovate, acute to acuminate. Calyptra large, cylindrical, plicate, twisted, covering the entire capsule, usually with a single split, often clasping the seta below, 1.35–1.70 mm long. Setae 0.5–1.0 mm long. Capsules emergent to exserted, ovoid; annulus absent or vestigial; stomata lacking; operculum c. 0.25 mm tall. Peristome lacking. Spores 25–30 µm diam. Plate 14.

Occurs in south-eastern Qld and north-eastern N.S.W.; grows on rock and tree trunks. Also in New Zealand and South America. Map 70.

Qld: Rifle Bird Ck, Binna Burra, *I.G.Stone 12893* (MEL). N.S.W.: Possum Shoot, Richmond R., 1902, *W.W.Watts* (NSW); Terania Creek Rd, Whian Whian, *I.G.Stone 13573* (MEL).

Erpodium glaucum var. *glaucum* differs from other taxa with a long calyptra (*E. beccarii* var. *longicalyptratum* and *E. hodgkinsoniae*) in the much smaller size and the 4-ranked leaves lacking a strong, hyaline hairpoint. It differs from *E. solmsiellaceum* and *E. biseriatum* in having leaves that are not as strongly dimorphic or obviously complanate. *Erpodium glaucum* var. *trichophyllum* (Ångstr. ex Müll.Hal.) I.G.Stone, from Africa and Asia, has leaves with a longer hairpoint and capsules with a 3-rowed annulus (Stone, 1997).

5. **Erpodium hodgkinsoniae** Hampe & Müll.Hal., *Flora* 70: 448 (1887)

Aulacopilum hodgkinsoniae (Hampe & Müll.Hal.) Broth., *Nat. Pflanzenfam*. I, 3: 711 (1905). T: Richmond R., N.S.W., 1879, *Mrs Hodgkinson*; holo: *n.v.*

Illustrations: V.F.Brotherus, *Nat. Pflanzenfam.*, 2nd edn, 11: 4, fig. 423E–K (1925); I.G.Stone, *J. Bryol*. 19: 493, fig. 2h–k (1997).

Stems to 30 mm long; branches short, erect or ascending. Rhizoids pale brown. Leaves green to yellowish, ±uniform, often secund, ±erect when dry, spreading when moist, 1.1–1.5 mm long, ovate-lanceolate; apex acute, tapering to a short or long smooth hyaline hairpoint; laminal cells smooth or occasionally with a single abaxial mammilla, ±rhomboidal in mid-leaf and 20–30 × 15–20 µm, ±quadrate at margin and alar region. Perichaetial leaves pale, to 3 mm long, ovate-acuminate, hyaline-awned. Calyptra c. 2.5 mm long; basal lobes split almost to apex into 8 laciniae, reaching to below the capsule. Setae c. 1.5 mm long. Capsules emergent, ±cylindrical, narrowed to the mouth, 1.3–1.5 mm long. 0.65–0.75 mm wide; annulus 4–6-rowed; operculum 0.3–0.4 mm. Peristome absent. Spores 25–35 µm diam.   Plate 16.

Endemic from north-eastern Qld to north-eastern N.S.W.; usually on the bark of native or exotic trees, sometimes on basaltic rock; often locally common.   Map 71.

Qld: Ingham, *I.G.Stone 14683* (MEL); 8 km E of Mt Morgan, *H.Streimann 52409* (CANB, NY). N.S.W.: Brunswick R., Myocum, *W.W.Watts 1600* (NSW); Victoria Forest Reserve, *D.H.Vitt 29264* (CANB); Victoria Park Nature Reserve, 17 km SE of Lismore, 11 Oct. 1996, *H.S.Curtis* (BRI, MEL).

Erpodium hodgkinsoniae differs from *E. coronatum* var. *australiense* in the more elongated, upper laminal cells and the coloured rhizoids, as well as in the calyptra and sporophyte. The gametophore superficially resembles that of *E. beccarii*, but the leaf cells are smooth rather than pluripapillose.

6. **Erpodium solmsiellaceum** (Müll.Hal. & Broth.) I.G.Stone, *J. Bryol.* 19: 487 (1997)

Wildia solmsiellacea Müll.Hal. & Broth., *Oefvers. Förh. Finska Vetensk.-Soc*. 33: 103 (1891).   T: Woolston Scrub, Qld, Nov. 1888, *C.Wild 18*; holo: H-BR.

Aulacopilum wildii Broth., *Oefvers. Förh. Finska Vetensk.-Soc.* 33: 103 (1891), *nom. nud*. (in synon.).

Illustrations: V.F.Brotherus, *Nat. Pflanzenfam.*, 2nd edn, 11: 6, fig. 421A–F (1925), as *Aulacopilum wildii*; I.G.Stone, *J. Bryol.* 19: 490, fig. 1a–j (1997).

Stems 10–30 mm long, irregularly branched, strongly complanate. Rhizoids smooth, reddish brown. Leaves dimorphic, 4-ranked; dorsolateral leaves oblong-orbicular, with a rounded apex, 0.65–0.75 mm long, 0.35–0.40 mm wide; ventral leaves lanceolate to narrowly lanceolate, with a rounded apex, 0.50–0.65 mm long, c. 0.15 mm wide; margin finely papillose; cells of dorsal leaves mostly 5–6-sided, 20–25 × 15–20 µm, smaller at the margin and often quadrate in alar regions, often elongated centrally near base, densely papillose; papillae compound, hollow, in C-shapes or circles, 6–12 per cell; cells of ventral leaves rhomboidal, to 50 × 10–12 µm, pluripapillose; papillae simple, some solid. Perichaetial leaves ovate, c. 1 mm long; apex acute or obtuse and short-acuminate; laminal cells rhomboidal, to 70 × 10–12 µm, pluripapillose; papillae smaller, simple and more distant than in vegetative leaves. Calyptra mitrate, plicate, covering at least half of the capsule, 0.8–1.0 mm long. Setae transparent, c. 1.0 mm long. Capsules c. 0.75 mm long and 0.5 mm wide; annulus c. 3-rowed; operculum c. 0.4 mm tall (including erect beak). Peristome present; teeth 120–160 µm long, narrowly lanceolate, densely papillose on both surfaces. Spores 20–30 µm diam.

Occurs in eastern Qld; epiphytic on trees and palm trunks near streams in rainforest subject to inundation during the wet season. Also in New Caledonia.   Map 72.

Qld: Mulgrave R., Lower Mulgrave, *I.G.Stone 26230* (MEL); Mooloolah Natl Park, *I.G.Stone 20730* (MEL); Tully R., Mrs Henry's property, Euramo, *I.G.Stone 18610* (MEL); Paynter Ck, Nambour, *I.G.Stone 13291* (MEL); River Rd, Indooroopilly, June 1900, *F.Whitteron* (NSW).

In *E. solmsiellaceum*, which closely resembles a leafy liverwort, the dorsal leaves, like those of *E. biseriatum*, are inflexed on the lower margin. The principal difference is in the type of papilla on the laminal cells; these differ on dorsal and ventral leaves of *E. solmsiellaceum* but are ±uniform in *E. biseriatum*. *Erpodium solmsiellaceum* also differs in the presence of a peristome and a mitrate calyptra.

SPLACHNACEAE

Bernard Goffinet[1]

Splachnaceae Grev. & Arn., *Mem. Wern. Nat. Hist. Soc.* 5: 442 (1824).

Type: *Splachnum* Hedw.

Dioicous acrocarpous mosses, green above, green to reddish below, rarely exceeding 5 cm in height. Stems orthotropic, with a well-defined central strand, surrounded by large parenchymatous cells with thin orange walls (reddish near the cortex); cortical cells narrow, thick-walled, reddish. Rhizoids dark red, papillose. Axillary branches infrequent to common. Female plants robust; leaves ovate-acute to ovate-lanceolate, erect-spreading, moderately crisped when dry; margin plane, entire, serrulate or serrate; costa single, ending below apex or excurrent, with up to 6 layers of stereids, covered by narrow moderately thick-walled rectangular cells on the adaxial and the abaxial surfaces; laminal cells thin-walled, flat to slightly bulging; basal cells rectangular; upper cells short-rectangular to quadrate, hexagonal and nearly isodiametric. Male plants slender, loosely foliated, with leaf size and differentiation increasing toward apex. Perigonia bulbous, forming a massive head; perigonial bracts strongly differentiated, ovate and long-acuminate; perichaetial leaves similar to vegetative leaves. Calyptra mitrate, lobed at base, bottle-shaped, yellow. Setae straight or slightly bent, smooth or scabrous in lower half; central strand present; cortical cells smaller than inner cells. Capsules exserted, erect; urn smaller than hypophysis, or hypophysis long and as wide as urn, tapering into seta and concolorous with urn, or much larger than urn, globose, to twice as broad as long and whitish; stomata absent or restricted to the hypophysis, phaneroporous; operculum conical. Peristome single; exostome of 8 teeth, incurved or recurved. Spores unicellular, thin-walled, smooth to faintly granulose, seemingly dispersed in clusters of variable size.

This family includes seven genera and approximately 70 species. These mosses occur primarily in the temperate zones of both hemispheres, except for *Brachymitrion* Taylor and *Moseniella* Broth. which are restricted to tropical latitudes. Only *Tayloria* and five species (one endemic) occur in Australia.

The family and most of its species are well known to bryologists for their coprophilous habitat (including dung and other decaying animal remains). Although the Australian species are seemingly not restricted to these substrata, they certainly flourish there.

V.F.Brotherus, Splachnaceae, *Nat. Pflanzenfam.*, 2nd edn, 10: 333–344 (1924); A.Koponen, The peristome and spores in Splachnaceae and their evolutionary and systematic significance, *Bryophyt. Biblioth.* 13: 535–567 (1977); A.Koponen, The generic classification of the Splachnaceae, *Nova Hedwigia* 71: 239–247 (1982); A.Koponen, The family Splachnaceae in Australia and the Pacific, *J. Hattori Bot. Lab.* 52: 87–91 (1982).

TAYLORIA

Tayloria Hook., *J. Sci. Arts* 2(3): 144 (1816); named after the English botanist Thomas Taylor (1786–1848).

Type: *T. splachnoides* (Schwägr.) Hook.

Eremodon Brid., *Bryol. Univ.* 1: 233 (1826), *nom. illeg.*, type of earlier name included (ICBN, Art. 52.1).

Plants erect. Leaves ovate-acute to ovate-lanceolate; laminal cells thin-walled, smooth, rectangular below, hexagonal or rectangular to quadrate above. Capsules exserted;

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hypophysis well differentiated, broad and whitish to narrow and pale to reddish. Exostome of 8 teeth. Chromosome number not known.

Tayloria comprises 40 species; five are endemic to Australasia, but only *T. gunnii* is known only from Australia. Koponen (1982) arranged the species of *Tayloria s. str.* among four subgenera, two of which are represented in Australia. Her classification rests exclusively on sporophytic characters, in particular the architecture of the peristome and the differentiation of exothecial cells. *Tayloria callophylla*, *T. gunnii* and *T. purpurascens* belong to subg. *Eremodon*, which is defined by the peristome being composed of eight small teeth that are bent inward when dry. Subgenus *Pseudotetraplodon* accommodates species with eight reflexed peristome teeth and thus includes *T. octoblepharum* and *T. tasmanica*.

G.O.K.Sainsbury, A handbook of New Zealand mosses, *Bull. Roy. Soc. New Zealand* 5: 1–490 (1955); A.Koponen & T.Koponen, The identity of *Splachnum turbinatum* and *Tayloria henryae* (Musci, Splachnaceae), *Ann. Bot. Fenn.* 15: 89–91 (1978); P.J.Dalton, R.D.Seppelt & A.M.Buchanan, An annotated checklist of Tasmanian mosses, *in* M.R.Banks *et al.* (eds), Aspects of Tasmanian Botany – A tribute to Winifred Curtis, 15–31. Royal Society of Tasmania, Hobart (1991).

1 Leaves broad and obovate, concave; costa ending well below apex .... **2. T. gunnii**

1: Leaves ovate-lanceolate; costa percurrent to excurrent 2

2 Peristome teeth incurved when dry at maturity *(1:)* 3

2: Peristome teeth recurved when dry at maturity 4

3 Leaves strongly serrulate to serrate; capsules pale brown *(2)* .... **1. T. callophylla**

3: Leaves entire to serrulate; capsules dark reddish brown .... **4. T. purpurascens**

4 Hypophysis strongly inflated, much broader than urn, grey-white at maturity *(2:)* ..... **5. T. tasmanica**

4: Hypophysis typically narrower or only slightly broader than urn, dark brown at maturity .... **3. T. octoblepharum**

1. Tayloria callophylla (Müll.Hal.) Mitt., *Trans. & Proc. Roy. Soc. Victoria* 19: 65 (1882)

Dissodon callophyllus Müll.Hal., *Bot. Zeitung (Berlin)* 9: 546 (1851); *Splachnum callophyllum* (Müll.Hal.) Wilson, *in* J.D.Hooker, *Fl. Tasman.* 2: 198 (1859). T: “Terra van Diemen, ad truncos et terra humida loco ‘Stern tree valley’ montis Wellington nuncupati” [Mt Wellington, Tas.], 1850, *S.Mossman 824*; lecto: NY, *fide* B.Goffinet, *Fl. Australia* 51: 410 (2006); isolecto: BM, JE; para: *S.Mossman 824* (BM, E?, NY).

Plants to 4 cm tall. Leaves ovate-lanceolate or obovate from a narrow base, and contracted to an acumen extending 20% of the leaf length, 2–4 times longer than wide, to 5 mm long and 1.5 mm wide; margin strongly serrulate to serrate from the lower 20% up, decurrent by 1 (rarely 2) rows of cells; costa c. 120 µm wide, ending below or in the base of acumen, green or red. Laminal cells slightly bulging; marginal cells short rectangular at the base, cells of serrulation longer, 60–210 × 20–50 µm; inner basal cells long-rectangular (except the most basal cells), 90–180 × 30–45 µm; upper cells 45–120 × 30–55 µm; cells of acumen long and narrow. Perichaetial leaves similar to vegetative leaves, but more erect. Setae straight or slightly bent, to 20 mm long and 0.3 mm thick, yellow, smooth. Capsules fusiform, to 5 mm long and 1.5 mm wide, yellow to pale brown; mouth narrow; urn to 3 mm long; neck to 2 mm, typically darker than urn, tapered and narrower than urn; exothecial cells of urn short-rectangular with oblate lumina above; anticlinal walls with heavy inward bulging thickening (lumina bone-shaped); exothecial cells of hypophysis longer, with irregular lumina, thickening heavy and bulging. Stomata few, scattered in upper part of neck. Operculum conical, to 0.3 mm long. Exostome teeth yellow, inserted well below capsule mouth, erect, with apices bent inward when dry, completely closing the capsule mouth when moist, to 255 µm long and 115 µm wide; OPL vertically lamellate; PPL thicker than OPL, densely reticulate to papillose at apex. Spores 7–9 µm diam. Fig. 17A–D.

In Australia, known only from the type locality in southern Tas., on “on trunks and humid soil”; also in New Zealand. Map 73.

Tayloria callophylla is readily recognised by its serrate to spinose leaf margins. Its sporophyte resembles that of *T. octoblepharum*, except for the incurved rather than

recurved peristome. Its occurrence in Tasmanian was considered doubtful by Dalton *et al.* (1991). The lectotype and one paratype (BM and NY) were, according to the label information, collected in Tasmania in 1850. However, this species has not been collected subsequently in Australia.

The specimen held in E and one of the two samples in BM bear a label with the number "123" and the date 1850. The locality description and the collector match those of the type collection, but the number does not. It is possible that the specimen is a duplicate of the original collection; whether it belongs to the lectotype (*824*) or the paratype (*823*) is not clear. Furthermore, the label of the specimen in E has "New Zealand"; this annotation seems to have be added later, since the handwriting differs slightly.

2. **Tayloria gunnii** (Wilson) J.H.Willis, *Victorian Naturalist* 67: 30 (1950)

Splachnum gunnii Wilson, *London J. Bot.* 7: 26, t. 1B (1848). T: on dead fern trees, Acheron River, Tas., *R.C.Gunn 1625*; lecto: BM, *fide* B.Goffinet, *Fl. Australia* 51: 410 (2006); isolecto: BM, NY, PC.

Splachnum grumii Paris, *Index Bryol.*, Suppl. 4: 364 (1905); *nom. inval*. (orthographic variant).

Tetraplodon gunnianum Rodway, *Pap. & Proc. Roy. Soc. Tasmania* 1913: 200 (1914); *nom. illeg*.; type of earlier name included (ICBN, Art. 52.1).

Tayloria obtusissima Broth., *Oefvers. Förh. Finska Vetensk.-Soc.* 37: 164 (1895). T: Falls Track, Mt Wellington, Tas., *W.A.Weymouth 1797*; lecto: H-BR, *fide* B.Goffinet, *Fl. Australia* 51: 410 (2006); isolecto: BM, CHR, NY.

Illustrations: W.Wilson, *J. Bot.* 7: 26, t. I (1848); J.H.Willis, *Victorian Naturalist* 67: 31, fig. A (1950); G.A.M.Scott & I.G.Stone, *The Mosses of Southern Australia* 266, pl. 50 (1976).

Dioicous(?). Plants to 3 (–9) cm tall. Leaves obovate-acute, less than twice as long as wide, concave, to 4 mm long and 2.5 mm wide; margin serrulate in upper half, decurrent by 1 (rarely 2) rows of cells; costa c. 60 µm wide, ending c. 6–10 cells below apex, green or red, composed of a central strand of stereids, with narrow moderately thick-walled rectangular cells on the adaxial and the abaxial surfaces. Laminal cells bulging; marginal laminal cells rectangular at the base and quadrate toward apex, 60–200 × 45–60 µm; submarginal cells narrower, c. 15 µm wide; inner basal cells long (except the most basal cells), 90–180 × 30–40 µm; upper cells 45–105 × 30–45 µm. Perigonia not seen. Perichaetial leaves similar to vegetative leaves, except for being slightly squarrose-recurved from a sheathing base. Calyptra not seen. Setae straight or slightly bent, to 10 mm long and 0.5 mm thick, dark red, scabrous at least in lower half. Capsules to 3 mm long and 2.5 mm wide, reddish brown or yellow with a reddish mouth; mouth narrow; urn to 2 mm long, with the base tapering to the strongly differentiated hypophysis, the latter broader than long, whitish and shrivelled when dry; exothecial cells of urn oblate, becoming progressively shorter toward apex, horizontal anticlinal walls extremely thickened, outer wall very thin and collapsing upon drying; exothecial cells of hypophysis elongate to irregular in shape, broader than those of the urn, (moderately) thick-walled but with broad lumina. Stomata few, with reddish guard cells. Operculum to 0.3 mm long. Exostome teeth yellow to orange, inserted well below capsule mouth, erect, with apices bent inward when dry, completely closing in the capsule mouth when moist, to 210 µm long and 135 µm wide; OPL vertically striate; PPL thicker than OPL, papillose to striate-papillose above. Spores 9–12 µm diam. Fig. 18E–H, Plate 15.

Endemic to Tas. where it grows probably exclusively on dung; occurs primarily in wet-sclerophyll forest at altitudes of 300–1100 m. Map 74.

Tas.: Cradle Mtn, *C.Skewes 41* (WELT); *loc. id*., L.Rodway (HO); *loc. id*., *A.Moscal 23250* (HO).

Tayloria gunnii is easily recognised by the broad hypophysis of the capsules and the obovate and concave leaves with large, lax cells. Although most specimens are up to c. 3 cm in height, the type of *T. obtusissima* reaches 9 cm. While all collections examined bear capsules, male sex organs have not been observed. If the species is indeed dioicous, it is possible that male plants are simply overlooked or ignored in the field in favour of the sporophyte-bearing female plants.

As with *T. tasmanica*, the coprophilous condition is not always obvious in old populations.

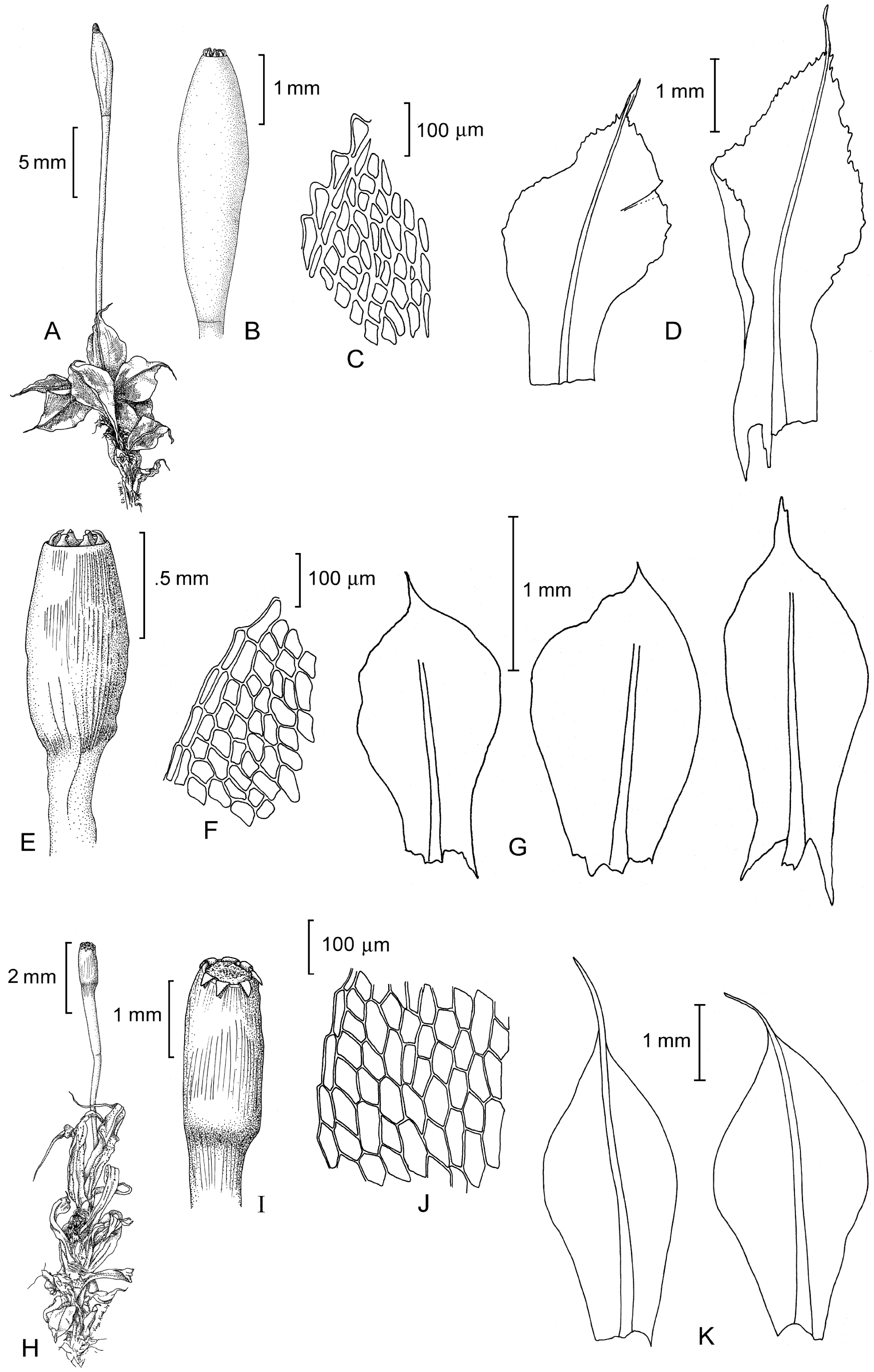

Figure 17. *Tayloria*. **A–D**, *T. callophylla*. **A**, Habit; **B**, Capsule (A, B, *Kirl* [New Zealand], NY); **C**, Upper laminal cells; **D**, Leaves (C, D, *S.Mossman 824*, NY). **E–G**, *T. purpurascens*. **E**, Capsule; **F**, Upper laminal cells; **G**, Leaves (E–G, *C.Müller*, NY). **H–K**, *T. octoblepharum*. **H**, Habit; **I**, Capsule; **J**, Upper laminal cells; **K**, Leaves (H–K, *H.Streimann 53094*, NY). Drawn by V.Kask.

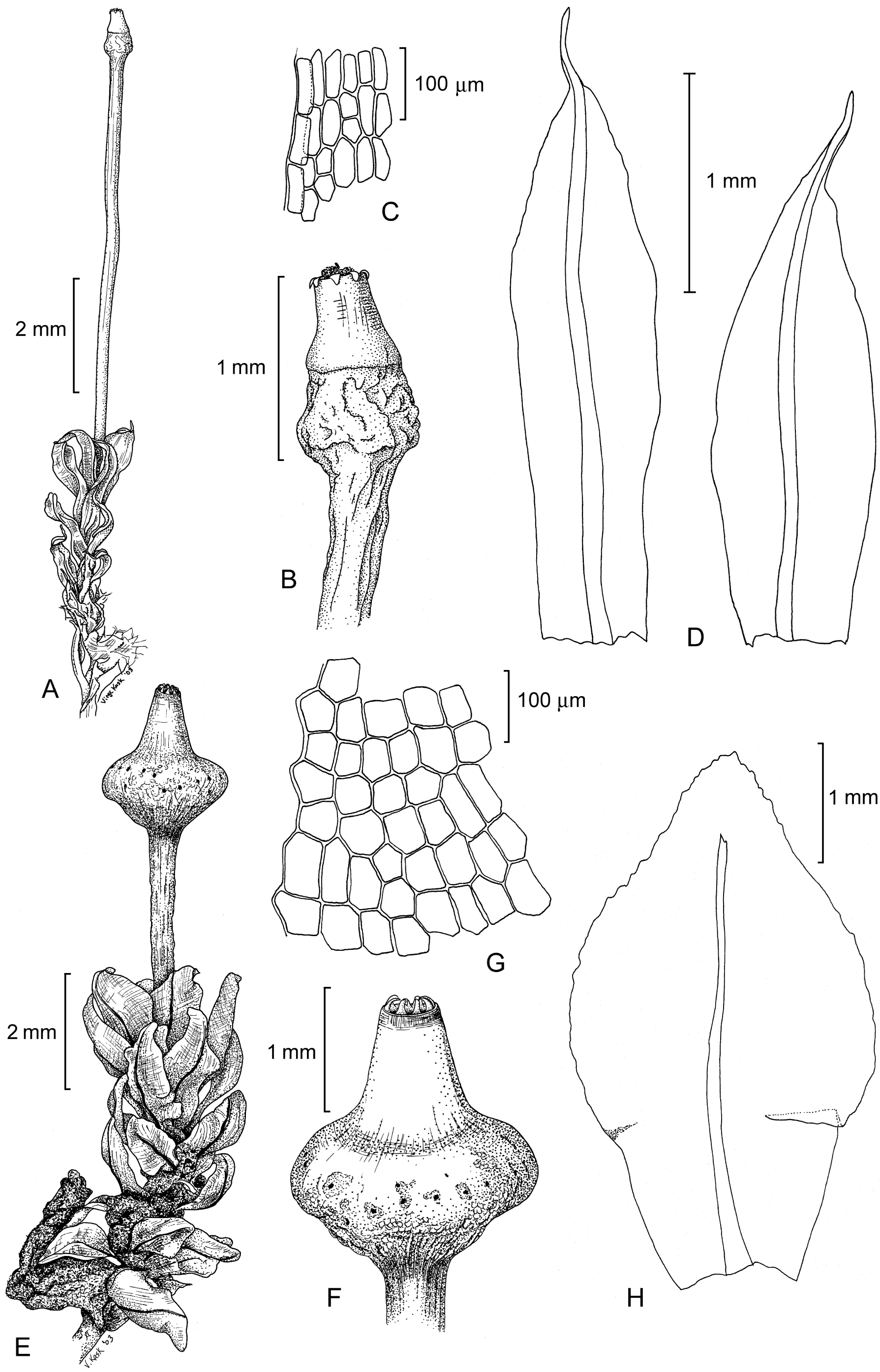

Figure 18. *Tayloria*. **A–D**, *T. tasmanica*. **A**, Habit; **B**, Capsule; **C**, Upper laminal cells; **D**, Leaves (A–D, *J.Jarman & G.Kantvilas*, HO). **E–H**, *T. gunnii*. **E**, Habit; **F**, Capsule; **G**, Upper laminal cells; **H**, Leaf (E–H, *Skewes*, WELT). Drawn by V.Kask.

3. Tayloria octoblepharum (Hook.) Mitt., *Trans. & Proc. Roy. Soc. Victoria* 19: 65 (1882)

Splachnum octoblepharum Hook., *Musc. Exot.* 2: 167 (1819); *Eremodon octoblepharum* (Hook.) Hook.f., *Fl. Nov.-Zel.* 2: 94 ('1855') [1854]; *Dissodon octoblepharum* (Hook.) Paris, *Index Bryol.* 385 (1896). T: "In truncis arborum emortuarum in Insula Van Diemen" [Tas.], *R.Brown*; lecto: BM, *fide* B.Goffinet, *Fl. Australia* 51: 410 (2006) [2 duplicates]; isolecto: BM, E, G.

Splachnum octoblepharum Hook. var. *pyriforme* Hook.f. & Wilson, *Fl. Antarct.* 1: 123 (1844); *Dissodon plagiopus* (Mont.) Müll.Hal. var. *pyriformis* (Hook.f. & Wilson) A.Jaeger, *Ber. Tätigk. St. Gallischen Naturwiss. Ges.* 1872–73: 194 (1874); *Tayloria octoblepharum* (Hook.) Mitt. var. *pyriformis* (Hook.f. & Wilson) Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 108 (1906). T: Campbell's Island, *[J.D.]Hooker*; lecto: NY, *fide* B.Goffinet, *Fl. Australia* 51: 410 (2006).

Splachnum octoblepharum Hook. var. *major* Hook.f. & Wilson, *Fl. Antarct.* 1: 124 (1844); *Dissodon plagiopus* (Mont.) Müll.Hal. var. *major* (Hook.f. & Wilson) A.Jaeger, *Ber. Tätigk. St. Gallischen Naturwiss. Ges.* 1872–73: 194 (1874); *Tayloria octoblepharum* (Hook.) Mitt. var. *major* (Hook.f. & Wilson) Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 108 (1906). T: Campbell's Island, *[J.D.]Hooker*; lecto: NY, *fide* B.Goffinet, *Fl. Australia* 51: 410 (2006).

Dissodon cuspidatus Müll.Hal., *Syn. Musc. Frond.* 1: 142 (1848), *nom. illeg.*, based on the same type as *T. octoblepharum*.

Dissodon plagiopus var. *minor* Müll.Hal. & Hampe, *Linnaea* 26: 491 (1855). T: "Irish Town"; *nom. inval. n.v.*

Dissodon novae-valesiae Müll.Hal., *Genera Musc. Frond.* 124 (1900); *Tayloria novae-valesiae* (Müll.Hal.) Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 107 (1906). T: "Östliche Australien, von der Provinz Victoria durch die Provinz Neu-Süd-Wales bis nach Queensland"; syn: *n.v.*

Dissodon nanocarpus Müll.Hal., *Genera Musc. Frond.* 124 (1900), *nom. inval*.

Dissodon pallescens Müll.Hal. ex Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 108 (1906); *Tayloria pallescens* Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 108 (1906), *nom. inval*. (in synon.). T: Murrumbeena, Vic., 1886, *F.M.Reader*; syn: CHR.

Illustrations: J.H.Willis, *Victorian Naturalist* 67: 31, fig. G (1950); G.A.M.Scott & I.G.Stone, *The Mosses of Southern Australia* 266, pl. 50 (1976); R.D.Seppelt, *The Moss Flora of Macquarie Island* 265, fig. 103 (2004).

Plants to 2 cm tall. Leaves ovate-spathulate, acuminate, to 3.5 mm long and 1.5 mm wide; margin typically entire, rarely serrulate, reflexed in mid-leaf, decurrent by 1 or 2 rows of cells; costa c. 140 µm wide, ending c. 6–10 cells below apex in lower leaves and short-excurrent in upper leaves, with an awn to 1.2 mm long, green or more commonly red, at least in older leaves. Laminal cells bulging; marginal cells rectangular at the base and quadrate toward apex, 60–150 × 15–30 µm; inner basal cells long-rectangular (except the most basal cells), 75–180 × 20–40 µm; upper cells 45–110 × 20–45 µm. Perigonia bulbous, terminal; perigonial leaves ovate, abruptly contracted into a long acumen. Perichaetial leaves larger than vegetative leaves and with a long-excurrent costa. Calyptra to 1.2 mm long. Setae straight to flexuose, to 11 mm long and 0.1 mm thick, orange-yellow. Capsules fusiform, to 4.5 mm long and 0.5 mm wide, yellowish green to reddish brown; mouth narrow; urn urceolate, to 1.1 mm long, usually dark reddish brown; neck well differentiated, to 4 mm long, gradually tapered to seta, concolorous with the urn or paler, occasionally arcuate, hollow and with a pseudocolumella at maturity; exothecial cells of urn short-rectangular to quadrate to wider than long; walls strongly thickened; lumina quadrate to irregular or narrowly oblate towards mouth; columella protruding from urn at maturity. Stomata few, in upper part of neck. Operculum conical or more rarely nearly flat, to 0.3 mm long. Exostome teeth yellow to orange, inserted well below capsule mouth, recurved when dry, completely closing in the capsule mouth when moist, to 180 µm long and 135 µm wide; OPL thick, papillose-vermicular; PPL thin, smooth. Spores 9–12 µm diam. Fig. 17H–K, Plate 17.

Known from W.A., S.A., south-eastern Qld, N.S.W., A.C.T., Vic. and Tas.; mainly in *Eucalyptus* forests, from sea level to 1600 m. Also in Papua New Guinea, New Zealand, Campbell Is., Chatham Is., Aucklands Is. and Macquarie Is. Map 75.

W.A.: Cannington, S of Perth, *G.E. & G. DuRietz 4676: 5* (WELT). S.A.: NW of Mt Gambier, *K.Stove* 975 (CANB). Qld: Palling Yard Ck, Stanthorpe, *H.Streimann 52935* (NY). N.S.W.: Central Tablelands, *W.W.Watts 10141* (NSW). A.C.T.: Brindabella Ra., *H.Streimann 1354* (CANB). Vic.: Bonang, *H.Streimann 35420* (MICH). Tas.: Arthurs L., Central Highlands, *A.Moscal 17248* (HO).

Tayloria octoblepharum is by far the most common of the Australian species, and thus, not surprisingly, the most variable, particularly in the shape and size of the leaves. However,

spathulate leaves, broadly reflexed margins, the filiform acumen and fusiform capsules with recurved peristome teeth are diagnostic. One specimen (*Streimann 53094*, NY) was found with two setae rather than one emanating from a single perichaetium. The variety *pyriforme* was distinguished by the narrow apophysis, a feature that is common and not particularly stable within populations, hence the variety is not recognised here. Similarly, var. *major* is placed in synonymy with the typical variety. This was defined by the 16 teeth being paired but not fused, a character that the only type material uncovered at NY failed to reveal, since all capsules were immature.

Buck *et al.* (*Key to the Genera of Australian Mosses* 107, 2002) referred to this species as *T. octoblepharis*, rather than *T. octoblepharum*. The use of "*octoblepharum*" as an adjective rather than a noun may, however, be erroneous. Indeed, as pointed out by Buck (pers. comm.), Hooker compared the peristome of this *Tayloria* to that of the genus *Octoblepharum*. Consequently, it appears that he is using the epithet "*octoblepharum*" as a noun in apposition, rather than an adjective. Thus it should remain unchanged in *Tayloria* as "*octoblepharum*".

The species tends to be coprophilous, with many populations sampled from cattle dung or other animal remains. However, numerous collections refer to tree trunks, soil and even rocks as substrata. Although this may suggest that *T. octoblepharum* is a facultative coprophile, it is possible that the original "animal" substratum was simply no longer obvious at the time of collection.

4. Tayloria purpurascens (Hook.f. & Wilson) Broth., *Nat. Pflanzenfam.* I, 3: 502 (1903)

Splachnum purpurascens Hook.f. & Wilson, *London J. Bot.* 3: 539 (1844). T: "Campbell's island [Campbell Is.]; in moist bogs, amongst grass; altitude 1000 feet", *J.D.Hooker*; lecto: BM, *fide* B.Goffinet, *Fl. Australia* 51: 411 (2006); isolecto: BM [4 duplicates], E.

Plants to 2 cm tall. Leaves broadly ovate-spathulate, to 3 mm long and 1.7 mm wide, acute, terminated by a short hairpoint (c. 0.4 mm long); margin entire to serrulate, reflexed in mid-leaf; costa c. 100 µm wide, ending c. 6–10 cells below apex in lower leaves and percurrent in upper leaves, green or more typically red at least in older leaves. Laminal cells plane to somewhat bulging; marginal cells rectangular at the base and quadrate toward apex, 60–165 × 25–30 µm; inner basal cells long-rectangular (except the most basal cells), 75–210 × 20–30 µm; upper cells 45–110 × 30–45 µm. Perigonia bulbous, terminal; perigonial leaves ovate, abruptly contracted into a long acumen. Perichaetial leaves larger than vegetative leaves, with a long-excurrent costa. Calyptra not seen. Setae straight to flexuose, to 8 mm long and 0.2 mm thick, orange-yellow. Capsules fusiform, to 2 mm long and 0.5 mm wide, dark reddish brown; mouth narrow; urn fusiform (widest in the middle) to 1 mm long, dark reddish brown; neck well differentiated, to 1 mm long, gradually tapered to the seta, concolorous with the urn, hollow and with a pseudocolumella at maturity; exothecial cells of urn short-rectangular to quadrate to mostly wider than long; walls strongly thickened, with horizontal walls thicker than vertical ones; lumina quadrate to irregular to mostly narrowly oblate in upper half. Stomata few in upper part of neck. Operculum conical, to 0.2 mm long. Exostome teeth reddish orange, inserted well below capsule mouth, incurved when dry, to 150 µm long and 90 µm wide; OPL thick, lamellate; PPL equally thick, papillose. Spores less than 10 µm diam. Fig. 17E–G.

The label for the only Australian collection indicates N.S.W., but it lacks more detailed information. This species is considered coprophilous by Koponen (1977). Map 76.

N.S.W.: locality unknown, *F.Mueller* (NY).

Tayloria purpurascens is characterised by the dark reddish brown, fusiform capsules with 8 incurved teeth lining the capsule mouth. Although it superficially resembles *T. octoblepharum*, sporophytic features (i.e. long capsules with incurved peristome) clearly link it to *T. callophylla*.

Sainsbury (1955) and Koponen (1982) considered this species to be endemic to the islands of New Zealand. Ramsay (Census of New South Wales mosses, *J. Linn. Soc. New South Wales* 2: 455–534, 1984) tentatively included *T. purpurascens* in her checklist of mosses of New South Wales based on an unreliable record from the Central Tablelands, and Streimann &

Klazenga (*Cat. Austral. Mosses* 202, 2002) excluded it from the Australian bryoflora. I have only seen a single Australian collection of *T. purpurascens*. The specimen is small but bears three well-developed capsules, and it agrees with material from New Zealand. The gametophyte is reminiscent of *T. callophylla* in that the leaves are somewhat serrulate (but not serrate), but the dark reddish capsule and the ornamentation of the peristome point to *T. purpurascens.* The specimen is from Jaeger's herbarium, and the label simply reads "*Dissodon purpurascens* Hpe (?), New South Wales, F. de Müller". The name "F. de Müller" confirms that the label was prepared by someone other than Mueller himself.

5. Tayloria tasmanica (Hampe) Broth., *Nat. Pflanzenfam.* I, 3: 502 (1903)

Tetraplodon tasmanicus Hampe, *Linnaea* 40: 302 (1876). T: "Mount. Tovers Lake Peddu" [mountain towards L. Pedder?], Tas., 1875, *Schuster*; holo: *n.v.*

Illustration: J.H.Willis, *Victorian Naturalist* 67: 31, fig. D (1950).

Plants to 2.5 cm tall. Female plants: leaves ovate-acute to ovate-lanceolate, to 3.5 mm long and 0.8 mm wide (typically 2–5 times longer than wide); margin decurrent by 1 (rarely 2) rows of cells; costa excurrent, c. 60 µm wide; mucro at least partially bistratose, with a stereid band ending in the lower half; basal marginal cells of lamina 120–180 × 25–30 µm; inner basal cells short- to long-rectangular, to 200 × 60 µm, often red-pigmented; upper cells 18–90 × 15–45 µm. Male plants: stems and branches bearing gametangia, slender, loosely foliated, with leaf size and differentiation increasing toward apex; sterile branches with leaves similar to but smaller than vegetative leaves of female plants, to 1.5 mm long; subapical branches common. Perichaetial leaves not differentiated from vegetative leaves, except for a percurrent costa in innermost leaves. Calyptra to 1.2 mm long. Setae to 13 mm long and 0.4 mm thick, dark red, scabrous at least in lower half. Capsules to 1.3 mm long and 0.8 (–1.0) mm wide; urn to 0.5 mm long, slightly conical, glossy, reddish brown, brown at mouth; hypophysis ±globose to twice as broad as long, whitish and shrivelled when dry, pale brown when moist, reddish brown in lower portion; tissue of hypophysis lax, spongy, red, differentiated in the upper portion in a pseudocolumella central to an air chamber; exothecial cells of urn oblate throughout, becoming progressively shorter toward apex; horizontal anticlinal walls uniformly thick; axial anticlinal walls unevenly thickened, with the lumen bone-shaped in T.S.; outer wall very thin and collapsing upon drying; exothecial cells of hypophysis elongate to irregular in shape, broader than those of the urn, thin-walled, not pigmented, or faintly so when old, separating from inner cells of hypophysis at or after maturity; neck below hypophysis typically short, rarely to 1.5 mm long. Stomata lacking. Operculum conical, to 0.3 mm long. Exostome teeth strongly recurved when dry, incurved and completely closing in the capsule mouth when moist, pale yellow, inserted well below the capsule mouth, to 310 µm long, slightly more than half lying below the capsule mouth; OPL with dense irregular short striation below, horizontally short-striate to papillose in upper half; PPL seemingly very thin, smooth or faintly papillose. Spores 9–12 µm diam. Fig. 18A–D.

Known from Tas., and from a single population sampled on Subantarctic Macquarie Is. in 1893 by Rodway (WELT M32030); grows on damp to wet soil in heathland, bryophyte-dominated peatland and in alpine scrub; found from sea level to about 1200 m. Map 77.

Tas.: NW of Cathedral Hill, *A.Moscal 24188* (HO); Adamson Peak, Dec. 1913, *L.Rodway* (WELT).

The capsules, with the hypophysis visible as a broad band between the dark reddish brown urn and the base of the capsule, are similar to those of *T. gunnii* from which this species differs by its narrower, acuminate leaves. The gametophyte of *T. tasmanica* resembles that of *T. octoblepharum,* but the leaf acumen of the latter is much longer.

It is surprising that none of the collections are reported to grow on dung or other animal remains. Indeed, the shape and colour of the capsule and the sticky spores are consistent with insect-mediated spore dispersal. Considering that all collections examined bear capsules, it is possible that lack of evidence for coprophily is an artifact due to the species only being collected when capsules are produced, which may occur long after the decomposition of the substratum.

Excluded Names

Tetraplodon mnioides (Hedw.) Bruch & Schimp., *Bryol. Eur*. 3: 215 (1844)

A specimen reminiscent in all its features of *T. mnioides s. lat*., and in particular of *T. lamii* Reimers, is filed under *Tayloria octoblepharum* in BM. This is labelled “Australia, RM 2958”. *Tetraplodon mnioides s. lat.* is a widespread species, being primarily circumboreal with disjunct occurrences in southern South America (as *T. fuegianum* Besch.) in New Guinea (as *T. lamii*), and in the mountains of Central Africa. The genus *Tetraplodon* is not known from Australia. Given that the annotations on the specimen are rather obscure, it is suggested that this specimen has been erroneously annotated as originating from Australia.

Tayloria maidenii Broth., *Proc. Linn. Soc. New South Wales* 41: 583 (1916)

T: Merritt’s Camp, Mt Kosciuszko, N.S.W., *J.H.Maiden & W.Forsyth 184*; lecto: H-BR, *fide* A.J.Fife & B.Goffinet, *Bryologist* 106: 309 (2003); isolecto: FH, S.

This species is characterised by an erect, smooth, gymnostomous capsule. In the protologue, Brotherus presents no justification for placing it in the Splachnaceae. Koponen (1982) suggested that the species does not belong here and Fife & Goffinet (*Bryologist* 106: 309–310, 2003) synonymised the name with *Entosthodon laxus* (Hook.f. & Wilson) Mitt. (Funariaceae), an Austral-Andean species known from Tasmania, Victoria and New South Wales (A.J.Fife, *Hikobia* 13: 473–490, 2001).

MEESIACEAE

Graham H. Bell[1] *& David G. Catcheside*†
[*Leptobryum* by *Helen P. Ramsay*]

Meesiaceae Schimp., *Coroll. Bryol. Eur.* 82 (1856).

Type: *Meesia* Hedw., *nom. cons.*

Monoicous or dioicous. Plants slender to robust. Stems unbranched or branching near base, with a central strand. Rhizoids basal or cauline, coloured and ornamented. Leaves ovate-lanceolate to narrowly lanceolate; costa single, strong, ending near apex or slightly excurrent; laminal cells smooth, almost quadrate to elongate-rectangular. Perichaetial leaves undifferentiated. Calyptra small, cucullate. Sporophytes terminal. Setae usually long, slender and flexuose. Capsules clavate to elongate-pyriform, slightly to strongly curved and asymmetrical, with a long apophysis; annulus present; operculum small, convex or short-conical, often apiculate. Peristome diplolepidous; exostome teeth 16; endostome of 16 segments from a basal membrane. Spores small to large.

A small family of five genera; three (*Amblyodon* P.Beauv., *Neomeesia* Deguchi and *Paludella* Brid.) are monotypic, *Meesia* comprises c. 10 species and *Leptobryum* five. The latter two genera occur in Australia. The distribution is predominantly cool- to cold-temperate in both hemispheres, and colonies occur as dense tufts in wet habitats. *Leptobryum* was recently transferred (Buck & Goffinet, 2000) from its traditional position in Bryaceae on the basis of nuclear and chloroplast DNA evidence (Cox & Hedderson, 1998).

V.F.Brotherus, Meeseaceae (sic), *Nat. Pflanzenfam.*, 2nd edn, 10: 443–445 (1924); A.J.E.Smith, Meesiaceae, *Moss Flora of Britain and Ireland* 451–453 (1978); C.J.Cox & T.A.J.Hedderson, *Pl. Syst. Evol.* 215: 119–139 (1998); D.H.Norris *et al.*, Bryophyte flora of the Huon Peninsula, Papua New Guinea. LXVI. Meesiaceae, *Ann. Bot. Fennici* 36: 257–263 (1999); W.R.Buck & B.Goffinet, Morphology and classification of mosses, *in* A.J.Shaw & B.Goffinet (eds), *Bryophyte Biology* 71–123 (2000).

KEY TO GENERA

Short slender annual plants with long flexuose leaves; growing on the ground in moist habitats, often weedy .. ..**1. LEPTOBRYUM**

Taller robust perennial plants with shorter erect or squarrose leaves; growing partly buried in subalpine boggy habitats.. **2. MEESIA**

1. LEPTOBRYUM

Helen P. Ramsay[1]

Leptobryum (Schimp.) Wilson, *Bryol. Brit.* 219 (1855); from the Greek *lepto* (delicate or slender) and *bryon* (a moss), in reference to the delicate leaves of these mosses.

Bryum subg. *Leptobryum* Schimp., *in* Bruch, Schimper & Gümbel, *Bryol. Eur.* 4: 1 (1851).

Type: *L. pyriforme* (Hedw.) Wilson

[1] State Herbarium of South Australia, Plant Biodiversity Centre, Hackney Road, Hackney, South Australia 5069.
[1] c/- National Herbarium of New South Wales, Royal Botanic Gardens and Domain, Mrs Macquaries Road, Sydney, New South Wales 2000.

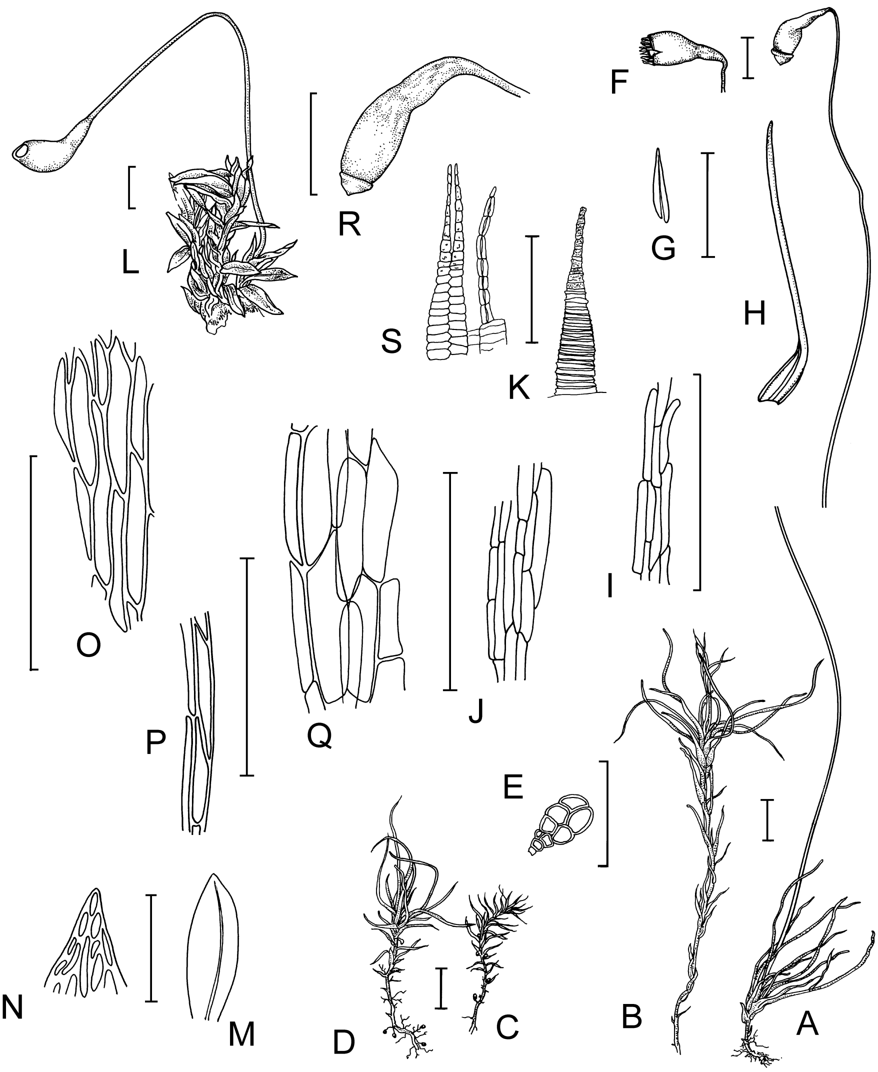

Figure 19. *Leptobryum* and *Plagiobryum*. **A–K**, *Leptobryum pyriforme*. **A**, Habit with sporophyte (dry specimen); **B**, Habit (dry male specimen); **C**, **D**, Gametophores with gemmae (axillary tubers); **E**, Gemma; **F**, Capsule with peristome; **G**, Stem leaf; **H**, Comal leaf; **I**, Marginal cells; **J**, Basal laminal cells (A–J, *R.G.Coveny 14374*, NSW); **K**, Exostome tooth (*W.Forsyth 1008*, NSW). **L–S**, *Plagiobryum cellulare*. **L**, Habit with sporophyte (dry specimen); **M**, Leaf; **N**, Apical cells; **O**, Mid-laminal cells; **P**, Marginal cells; **Q**, Basal laminal cells; **R**, Capsule; **S**, Endostome tooth (left) and segment (right) (L–S, isotype of *Bryum wildii*, NSW). Scale bars: 1 mm for habit; 0.5 mm for leaves; 100 µm for cellular drawings. Drawn by L.Elkan.

Synoicous, sometimes dioicous. Plants small, in dense tufts, radiculose at the base. Stems slender, unbranched. Rhizoids coloured, papillose. Upper leaves long, in comal tufts, crisped when dry, setaceous from a lanceolate base; margin entire or distantly denticulate above; leaf base sheathing. Lower leaves distant, small, lanceolate; costa single, broad, flat, percurrent or failing below apex. Gemmae sometimes present in leaf axils or as tubers on rhizoids. Perichaetial leaves undifferentiated. Calyptra cucullate, smooth, glabrous. Setae long, thin, flexuose. Capsules strongly inclined to pendulous, pyriform with a long narrow neck, glossy; operculum convex, apiculate. Peristome double; exostome teeth 16, lanceolate-acuminate, yellowish, densely papillose, trabeculate; endostome segments hyaline, finely papillose, c. as long as teeth or shorter; segments keeled and perforate; basal membrane high; cilia in 3s (sometimes in 4s), appendiculate. Spores globose, papillose. *n* = 20, 21, 22, 33, *fide* R.Fritsch, *Bryophyt. Biblioth.* 40: 192 (1991).

A genus of two species; represented in Australia by the weedy, cosmopolitan *L. pyriforme*.

T.Arts, The moss genus *Leptobryum* and the identity of *Pohlia integra*, *J. Bryol.* 23: 325–330 (2001).

Leptobryum pyriforme (Hedw.) Wilson, *Bryol. Brit.* 219 (1855)

Webera pyriformis Hedw., *Sp. Musc. Frond.* 169 (1801). T: Europe; *n.v.*

Leptobryum sericeum Kindb., *Enum. Bryin. Exot.* 63 (1888); *Pohlia sericea* (Kindb.) Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 123 (1906). T: Tas., *Stuart*; *n.v.*

Bryum senodictyon Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 122 (1906), *nom. nud.* (in synon.). Based on: Gawler R., 1848, *F.Mueller s.n.* (MEL).

Leptobryum senodictyon Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 122 (1906), *nom. nud.*

Illustrations: D.G.Catcheside, *Mosses of South Australia* 247, fig. 142 (1980); J.E.Beever, K.W.Allison & J.Child, *Mosses New Zealand*, 2nd edn 97, fig. 42 (1992); A.Eddy, *Handb. Malesian Mosses* 3: 163, fig. 442 (1996).

Usually synoicous. Plants soft, 1–3 cm tall. Rhizoids densely and finely papillose, brown to crimson or violet. Upper leaves lanceolate-subulate from a short sheathing base, 2–5 mm long, entire above, spreading and flexuose when moist or dry. Lower leaves rudimentary; costa percurrent; upper laminal cells short, especially at margins; mid-leaf cells linear, 80–90 × 8–9 µm, rhomboidal at base. Gemmae sometimes abundant, ovoid, multicellular, red-brown, in lower leaf axils or as tubers on underground rhizoids, pitted. Setae 1–3 cm long, reddish. Capsules 1.7–2.5 mm long, ribbed when old and dry. Exostome teeth finely papillose on dorsal face; trabeculate on inner; endostome segments shorter than exostome teeth, perforated in midline; cilia as long as segments. Spores 12–18 µm, finely papillose. *n* = 22 (20 + *2m*), *fide* H.P.Ramsay, *Austral. J. Bot*. 22: 312 (1974). Fig. 19A–K, Plate 18.

Occurs in W.A., S.A., N.T.(?), Qld(?), N.S.W., A.C.T., Vic. and Tas. An annual, almost cosmopolitan species that is found on all continents except Antarctica; most common in temperate regions. This is a weed on pots in glasshouses; infrequent on damp earth, burnt soil or limestone. Map 78.

W.A.: Melaleuca Grove, Beverley Springs, Kimberley, 1 May 1988, *G.A.M.Scott* (MEL). S.A.: 33 km WSW of Kingscote, Kangaroo Is., *H.Streimann 54871* (CANB). N.S.W.: Yarrangobilly Caves, *W.W.Watts 8734* (NSW). A.C.T.: CSIRO, Black Mtn, *E.D'Arney 349* (CANB). Vic.: Grampians Natl Park, *A.C.Beauglehole 4182* (MEL). Tas.: near Parsons Bay, Tasman Penin., *W.A.Weymouth 613* (AD, HO).

This moss is characterised by comal tufts of slender leaves with broad, clasping bases, coloured rhizoids and long setae with pyriform capsules. Apart from gemmae (bulbils and tubers), deciduous shoots can also disperse this species.

2. MEESIA

Graham H. Bell[1] *& David G. Catcheside*†

Meesia Hedw., *Sp. Musc. Frond.* 173 (1801), *nom. cons.*; named for the Dutch gardener David Meese (1723–70).

Type: *M. longiseta* Hedw., *typ. cons*.

Perennial plants in rather dense caespitose tufts, yellowish green to green or dark green above, brown to blackish below. Lower stems densely matted with rhizoids, occasionally branching; basal portions mostly buried in mud. Leaves decurrent, suberect to squarrose from an erect base, smooth, oval-oblong to lanceolate or lingulate; costa strong, wide at base, ending below apex to short-excurrent; upper laminal cells small, rectangular, somewhat incrassate; basal cells larger, rectangular, hyaline. Setae long. Capsules elongate-pyriform, curved, with the apophysis equal in size to the theca; operculum small, conical, obtuse; annulus double. Exostome short, usually less than half the height of the endostome, finely papillose; outer plates large; inner lamellae low; endostome processes linear-lanceolate with a hyaline border, keeled and somewhat perforate along the keel, ±smooth, sometimes joined apically; rudimentary cilia occasionally present. Spores large. Chromosome number variable (n = 10, 13, 14, 20), *fide* R.Fritsch, *Regnum Veg.* 108: 152 (1982).

A genus of about 10 species, found in Europe, North and South America and Asia; two species are known from Australia and New Zealand. The only African species (*M. kenyae* P. de la Varde) was recently placed in synonymy with *Ceratodon purpureus* (Hedw.) Brid. (Ditrichaceae; R.Ochyra, *Cryptogamie Bryologie* 22: 23–28, 2001). Colonies occur as dense tufts in wet boggy habitats, often with *Sphagnum*.

Leaves in 3 rows, squarrose; leaf margin serrate; apex elongate and narrowly acute; rhizoids finely papillose .. .. **2. M. triquetra**

Leaves in 5–8 rows, not squarrose; leaf margin entire; apex bluntly acute; rhizoids coarsely verrucose .... **1. M. muelleri**

1. Meesia muelleri Müll.Hal. & Hampe, *Linnaea* 28: 208 (Sept. 1856)

T: Cobberas Mountain, [Vic.], 1854, *F.Mueller*; holo: BM (Herb. Hampe) *n.v.*; iso: MEL *n.v.*, NSW 366234.

Meesia macrantha Mitt., *Hooker's J. Bot. Kew Gard. Misc.* 8: 260 (Sept. 1856)., *nom. illeg.*, based on same type as *M. muelleri* [placed in synonymy under *M. muelleri* by Mitten himself (*Trans. & Proc. Roy. Soc. Victoria* 19: 70, 1882)]. T: Cobberas Mountains, [Vic.], *F.Mueller*; holo: NY (Herb. Mitten); iso: BM, MEL, NSW.

Illustration: W.R.Buck, D.H.Vitt & W.M.Malcolm, *Key to the Genera of Australian Mosses* 97 (2002).

Autoicous. Plants green to yellow-green, 2–5 (–10) cm tall, the uppermost 1–2 cm is annual growth. Rhizoids crimson, densely verrucose. Leaves erect when dry, little changed when moist; oblong-lingulate to narrowly lanceolate, 1.5–3.0 mm long, 0.4–0.5 mm wide, broadly carinate; margin entire; costa c. 150 µm wide at base; laminal cells short-rectangular, increasing in size from 20–30 × 10 µm apically to 40–60 × 15–20 µm at the base. Axillary hairs to 200 µm long, with 2 or 3 rectangular reddish basal cells and 1 elongate hyaline apical cell. Androecia discoid. Setae reddish brown, flexuose, 1.5–4.0 cm tall. Capsules pyriform, c. 2 mm long and 0.8–1.0 mm wide, curved and gibbous, with the peristome at right angles to ground. Peristome pale; cilia rudimentary or absent. Spores green or brown, 40–55 µm diam., densely covered with fine papillae and ridges.

Occurs in scattered colonies in bogs, often with *Sphagnum*, in open grassland amid subalpine sclerophyll forest in N.S.W., A.C.T. and Vic. Usually with large numbers of sporophytes when fertile; also in New Zealand. Map 79.

[1] State Herbarium of South Australia, Plant Biodiversity Centre, Hackney Road, Hackney, South Australia 5069.

N.S.W.: Badja Sawmill, NE of Cooma, *M.Mueller 2019* (AD, MEL); Swamp Caves, Kiandra Rd, Yarrangobilly, *W.W.Watts 8891* (NSW). A.C.T.: Gibraltar Ck, Back Flat, *L.G.Adams 1562* (CANB, NSW). Vic.: Lankey Plain, Dargo High Plains, *H.Streimann 53266* (CANB).

2. Meesia triquetra (L. ex Jolycl.) Ångstr., *Nova Acta Regiae Soc. Sci. Upsal.* 12: 357 (1844)

Mnium triquetrum L. ex Jolycl., *Syst. Sex. Vég.* 76 (1803). T: Europe; *n.v.*

Illustrations: D.H.Norris *et al.*, *Ann. Bot. Fennici* 36: 259, fig. 1 (1999); A.J.E.Smith, *Moss Flora of Britain and Ireland* 452, figs 4, 5 (1978).

Dioicous. Plants dark green above, brown to black below, 3–5 (–12) cm tall. Rhizoids crimson, finely papillose. Leaves curled to strongly crisped when dry, in 3 rows, squarrose, spreading from an erect hyaline sheathing base, ovate-lanceolate or the upper portion narrowly triangular, 2–4 mm long, 0.8–1.0 mm wide, carinate above, gradually narrowed to an acute apex; margin serrate from projecting cell ends; costa strong, almost percurrent to short-excurrent; upper laminal cells 20–24 × 10–16 µm; lower cells 50–60 × 20 µm. Axillary hairs to 200 µm long, with 2 or 3 short brown basal cells and a single elongate hyaline apical cell. Androecia discoid. Setae 3–10 cm long. Capsules elongate-pyriform, curved, 4–6 mm long. Peristome brownish to hyaline; cilia 3, short. Spores globose, to 40 µm diam., yellow-brown, finely papillose. n = 10, 20, *fide* R.Fritsch, *Regnum Veg.* 108: 79 (1982).

Occurs in medium-sized colonies in swampy, grassy areas amid subalpine sclerophyll forest, apparently restricted to the Great Dividing Range in south-eastern N.S.W., A.C.T. and Vic. Widespread in the Northern Hemisphere (North America, Europe and northern and eastern Asia). Map 80.

N.S.W.: Badja sawmill, NE of Cooma, *M.Mueller 2015* (AD, MEL, NSW). A.C.T.: Smokers Flat, *H.Streimann 53401* (AD, CANB, HO). Vic.: Black Mountain Rd, Rocky Plains, East Gippsland, *I.G.Stone 11493* (MEL).

No sporophytes were seen in Australian specimens.

ORTHOTRICHACEAE

Helen P. Ramsay[1], *Dale H. Vitt*[2] *& Jette Lewinsky-Haapasaari*†

Orthotrichaceae Arn., *Disp. Méth. Mousses* 13 (1825–26).

Type: *Orthotrichum* Hedw.

Dioicous, pseudautoicous or phyllodioicous with dwarf males, or autoicous, rarely synoicous. Plants acrocarpous or cladocarpous in loose or dense tufts, cushions or mats. Stems simple or branched, upright or creeping with upright branches; innovating branches lateral, below the sporophyte. Leaves imbricate, crowded, erect to erecto-patent when moist, appressed, flexuose or twisted, crisped or contorted when dry, lanceolate, ovate-lanceolate, oblong-lanceolate, oblong-elliptical, linear-lanceolate to linear, ligulate or occasionally lingulate, sometimes keeled, mostly entire; upper part of leaf unistratose, sometimes bistratose or multistratose; costa single, ending well below apex, percurrent or excurrent; upper laminal cells chlorophyllose, rounded to hexagonal, quadrate or short-rectangular to rhomboidal, rarely elongate, smooth, flat or bulging, mammillose or papillose and thick-walled; basal cells short-rectangular to linear, rarely hexagonal-rhomboidal, thin- or thick-walled, the walls sometimes nodose, smooth, papillose or with a single spiculose papilla; hyaline basal border present in some taxa; alar cells undifferentiated. Gemmae present or absent. Perichaetia terminal, with differentiated or undifferentiated leaves. Calyptra usually large, mitrate to mitrate-oblong or conical-oblong, rarely campanulate or cucullate, hairy or glabrous. Setae short or long, usually smooth, sometimes twisted. Capsules immersed, emergent or exserted, erect when dry, symmetrical, broadly ovoid, oblong, cylindrical, pyriform or fusiform, rarely urceolate when dry, smooth or ribbed; operculum rostrate, rarely oblique. Peristome diplolepidous, single, double or absent; exostome teeth 8, 16 or absent, sometimes reduced, often curved when dry; endostome segments 8, 16 (rarely 32), reduced or absent; cilia absent. Spores isomorphic or anisomorphic, usually unicellular, rarely multicellular, papillose.

The family Orthotrichaceae includes c. 20 genera with c. 550 species that are widely distributed as epiphytes in temperate and tropical forests, the largest genera occurring in the Pacific region. Represented in Australia by eight genera and 42 species as well as 2 additional varieties and one subspecies; 17 taxa are endemic (*Macromitrium* 12 species; *Schlotheimia* 1; *Stoneobryum* 1; *Ulota* 1 species and 2 varieties). The family is an important component of the epiphytic bryoflora of Australia, often occurring in the canopy or at rainforest margins; also found on tree trunks and rocks. Many species are drought-tolerant and strongly hygroscopic.

The family comprises two subfamilies: Orthotrichoideae (*Orthotrichum*, *Stoneobryum*, *Ulota* and *Zygodon*) is predominantly temperate in both hemispheres, while the Macromitrioideae (*Groutiella*, *Macrocoma*, *Macromitrium* and *Schlotheimia*) is mainly tropical, subtropical and temperate in the Southern Hemisphere.

The systematic position of *Amphidium* Schimp. has been the subject of controversy. Many workers have placed it in Orthotrichaceae based on the sulcate capsule and differentiated strips of exothecial cells similar to *Zygodon*. However, the lack of a peristome has led others to believe the genus to be haplolepidous and to place it in Rhabdoweisiaceae (Vitt, 1973, 1984). Malta (1926) favoured its inclusion in Orthotrichaceae, and Lewinsky (1976) provided evidence based on capsule sections, the hairs on the calyptra and other data to support its inclusion in Orthotrichaceae. Recent studies of nucleotide sequences as well as the presence or absence of small branchlets in the upper leaf axils, the type of rhizoid insertion,

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the pattern of papillosity on lateral and transverse walls and lumina, and habitat preferences support placement in the Rhabdoweisiaceae close to the Dicranaceae (Norris & Koponen, 1999; Shaw & Goffinet, 2000). The genus will be treated as part of Rhabdoweisiaceae in a future volume of the *Flora of Australia*.

G.Arnott, Orthotrichoideae, *Disp. Méth. Mousses* 13 (1825); V.F.Brotherus, Orthotrichaceae, *Nat. Pflanzenfam.*, 2nd edn, 11: 10–49 (1925); N.Malta, Die Gattung *Zygodon* Hook. et Tayl. Eine monographische Studie, *Acta Horti Bot. Univ. Latv.* 1: 1–184 (1926); D.H.Vitt, The infrageneric evolution, phylogeny and taxonomy of the genus *Orthotrichum* (Musci) in North America, *Nova Hedwigia* 21: 683–711 (1972); D.H.Vitt, A revision of the genus *Orthotrichum* in North America, north of Mexico, *Bryophyt. Biblioth.* 1: 1–208 (1973); J.Lewinsky, On the systematic position of *Amphidium* Schimp., *Lindbergia* 3: 227–231 (1976); D.H.Vitt, The genera of Orthotrichaceae, *in* P.Geissler & S.W.Greene (eds), Bryophyte Taxonomy, *Beih. Nova Hedwigia* 71: 261–268 (1982); D.H.Vitt, Classification of Mosses, *in* R.M.Schuster (ed.), *New Manual of Bryology* 2: 696–759 (1984); J.Lewinsky, Does the Orthotrichaceous type of peristome exist? *J. Hattori Bot. Lab.* 67: 335–363 (1989); H.P.Ramsay, Chromosome studies on some Australasian Orthotrichaceae II. *Ulota* and *Zygodon* with additional studies on *Orthotrichum*, *Schlotheimia* and *Macromitrium*, *J. Hattori Bot. Lab.* 74: 183–192 (1993); B.Goffinet & D.H.Vitt, Revised generic classification of the Orthotrichaceae based on a molecular phylogeny and comparative morphology, *in* J.W.Bates, N.W.Ashton & J.G.Duckett (eds), *Bryology in the Twenty-first Century* 143–160 (1996); B.Goffinet, R.J.Bayer & D.H.Vitt, Circumscription and phylogeny of the Orthotrichaceae (Bryopsida) based on rbcL sequence analyses, *Amer. J. Bot.* 85: 1324–1337 (1998); D.H.Norris & T.Koponen, Bryophyte flora of the Huon Peninsula, Papua New Guinea. LXVII. *Amphidium* (Rhabdoweisiaceae, Musci), *Ann. Bot. Fenn.* 36: 265–269 (1999); A.J.Shaw & B.Goffinet, *Bryophyte Biology*. Cambridge University Press, Cambridge (2000).

KEY TO GENERA

1 Stems erect-ascending, simple or sparingly branched; plants acrocarpous, with capsules on main (primary) stem 2

1: Stems creeping, freely branched, with numerous erect branches; plants cladocarpous, with capsules on erect (secondary) branches 5

2 Gemmae usually present in leaf axils, never on leaves; calyptra cucullate, not plicate; capsules long-exserted *(1)* .... **8. ZYGODON**

2: Gemmae (if present) on leaves, not in leaf axils; calyptra mitrate or conical, ±plicate; capsules immersed, emergent or exserted 3

3 Upper laminal cells smooth or sometimes slightly bulging (mammillose); perichaetial leaves pale, enlarged; capsule immersed in perichaetium, on a very short seta; stomata immersed *(2:)* .... **6. STONEOBRYUM**

3: Upper laminal cells papillose; perichaetial leaves not or slightly differentiated; capsule not immersed in perichaetium; seta short or long; stomata immersed or superficial 4

4 Leaves bordered near base; marginal cells quadrate to short-rectangular; transverse walls hyaline and thick; capsules exserted, with a long tapering neck; stomata superficial, often restricted to the neck; calyptra hairy *(3:)* .... **7. ULOTA**

4: Leaves not bordered near base; capsules immersed or exserted; stomata superficial or immersed, on the urn; calyptra glabrous or hairy .... **4. ORTHOTRICHUM**

5 Leaves straight, tightly erect-appressed, small and tightly spirally imbricate, not twisted or flexuose; apices not inrolled when dry *(1:)* .... **2. MACROCOMA**

5: Leaves erect-curved, erect-whorled, funiculate in spirals around stem, or each leaf twisted-contorted when dry, with decurved to recurved apices, twisted to tightly inrolled when dry 6

6 Branch leaves ending in a long fragile subula, bordered in lower half by 2–5 rows of elongate hyaline cells *(5:)* .... **1. GROUTIELLA**

6: Branch leaves without a long fragile subula, not bordered in lower half 7

7 Plants vivid dark green above, with a dense red tomentum below; laminal cells smooth; calyptra not plicate, enclosing capsule at maturity .... **5. SCHLOTHEIMIA**

7: Plants bright green or yellow-orange above, with dark brown tomentum below; laminal cells papillose, mammillose or smooth; calyptra plicate, not enclosing capsule at maturity......... **3. MACROMITRIUM**

1. GROUTIELLA

Dale H. Vitt[1] *& Helen P. Ramsay*[2]

Groutiella Steere, *Bryologist* 53: 145 (1950); named after Abel Joel Grout (1867–1947) who helped segregate the genus from *Macromitrium*.

Type: *G. schlumbergeri* (Schimp. ex Besch.) Wijk & Margad.

Dioicous (in Australia). Plants medium-sized to robust, forming irregular spreading mats, olive-green above, darker below. Stems creeping, with slender dense erect flexuose branches, the branches simple or sparsely branched and with a rufous tomentum. Stem leaves erect-flexuose when dry, wide-spreading and flexuose when moist, partly hidden by tomentum, ovate-lanceolate; apex subulate; costa ending in the subula. Branch leaves spirally twisted around the stem, oblong-lanceolate to ligulate-lanceolate; apex acute, reflexed outwards when dry, wide-spreading and straight when moist, with a rigid fragile subula; proximal leaf border of 2–5 rows of elongate flat hyaline cells extending to mid-leaf; costa conspicuous, ending in the subula; base narrowly ovate-oblong. Gemmae absent. Perichaetial leaves ±undifferentiated. Sporophyte not known in Australian material. Chromosome number not known.

A pantropical genus of 17 species, found in tropical America, Sri Lanka, Java, Australia, New Guinea and the Philippines; mainly epiphytic, but also on rock. Represented in Australia by a single species.

D.H.Vitt & H.A.Crum, *Groutiella tomentosa* new to the United States, *Bryologist* 73: 145–149 (1970).

Groutiella tomentosa (Hornsch.) Wijk & Margad., *Taxon* 9: 51 (1960)

Macromitrium tomentosum Hornsch., *in* C.F.P.Martius, *Fl. Bras*. 1(2): 21 (1840). T: Uruguay; *n.v.*

Illustrations: H.A.Crum & L.E.Anderson, *Mosses of Eastern North America* 2: 740, fig. 352 (1981); D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 432, figs 328–329; 433, figs 333–340 (1985).

Stems 10 (–20) mm long, simple or once-branched below perichaetia. Stem leaves 0.9–1.2 mm long; apex sharply acuminate, subulate. Branch leaves irregularly flexuose from a narrowly obovate base, keeled, 1.6–2.7 mm long, with an acute apex, the upper third gradually extended to form a broad fragile green subula; subula partly bistratose, with cells rounded-quadrate, flat, smooth, 5–9 µm wide; margin broadly reflexed, entire; costa conspicuous; upper and mid-laminal cells unistratose, subelliptical to rounded, 6–8 µm wide, thick-walled, smooth; basal laminal cells ±similar, hexagonal-rhomboidal, 9–12 µm wide, thick-walled, strongly bulging, a few cells at insertion clear, broad, thin-walled and 12–14 µm wide, forming a border proximally. Perichaetial leaves similar to vegetative leaves but with a more elongate and robust subula. Fig. 20A–I.

A pantropical species known in Australia from only a few collections in north-eastern Qld; usually epiphytic on trees, rarely on rock. Map 81.

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[2] c/- National Herbarium of New South Wales, Royal Botanic Gardens and Domain, Mrs Macquaries Road, Sydney, New South Wales 2000.

Qld: near Carrington Falls, S of Atherton, *D.H.Norris 43540* (NSW); Mt Windsor Rd, near Mt Carbine, *D.H.Norris 43108* (NSW); Hugh Nelson Ra., *H.Streimann 29398* (CANB); Danbulla State Forest, 23 km SE of Mareeba, *H.Streimann 57730* (CANB); Cardwell Ra., 45 km NW of Cardwell, *H.Streimann 36934* (CANB).

Australian plants are much smaller than those from New Guinea and the Philippines. At present, only female plants are known in Australia, and while these possess archegonia, none have been found to be fertilised. It is likely that the Australian plants represent a recent, long-distance dispersal from the north by vegetative diaspores (leaf fragments or fragile apices).

Groutiella tomentosa is distinguished from *Macromitrium* in Australia by the fragile branch leaf subulae that are green and partly bistratose, and branch leaves that are wound spirally around the branch. The proximal border of 2–5 rows of elongate, flat cells is also distinctive.

2. MACROCOMA

Dale H. Vitt[1] *& Helen P. Ramsay*[2]

Macrocoma (Hornsch. ex Müll.Hal.) Grout, *Bryologist* 47: 4 (1944); from the Greek *macro* (large) and *coma* (a tuft of hairs), in reference to the long hairs on the calyptra.

Type: *M. filiforme* (Hook. & Grev.) Grout

Macromitrium sect. *Macrocoma* Hornsch. ex Müll.Hal., *Bot. Zeitung (Berlin)* 3: 522 (1845); *Macromitrium* subg. *Macrocoma* (Hornsch. ex Müll.Hal.) Broth., *Nat. Pflanzenfam*. I, 3: 477 (1902).

Autoicous. Plants slender to filiform, forming dull tangled olive-brown mats. Stems creeping, irregularly and subpinnately branched, with erect ascending widely spaced slender terete branches. Branch leaves regularly arranged, imbricate, forming spiralled ranks, tightly erect-appressed when dry, erect-spreading when moist, narrowly lanceolate-ligulate, keeled; apex bluntly acute to obtuse; margin entire; costa strong, ending near the apex; upper laminal cells rounded to hexagonal, smooth, flat; basal cells linear to rectangular, thick-walled, bulging or mammillose (especially near the leaf base). Gemmae rare, fusiform. Calyptra large, covering the capsule, mitrate, plicate, hairy. Setae elongate, smooth. Capsules on erect secondary branches, exserted, cylindrical or fusiform, usually plicate when dry and empty (at least at the mouth); operculum conico-rostrate. Peristome double; exostome sometimes reduced to a membrane; endostome consisting of a pale delicate papillose membrane or with 16 short blunt segments. Spores unicellular, globose, isomorphic, finely papillose.

Known from southern Africa, East Asia, Australasia and western North America. Only one of the nine species occurs south of the Equator, being present in Australia, New Zealand and southern Africa.

Macrocoma is separated from *Macromitrium* by the slender, terete, widely spaced and widely spreading branches, appressed leaves, short cells of the leaf bases, and the large, hairy, mitrate calyptrae.

A.J.Grout, Preliminary synopsis of the North American *Macromitriae*, *Bryologist* 47: 1–22 (1944); D.H.Vitt, A revisionary study of the genus *Macrocoma*, *Rev. Bryol. Lichénol*. 39: 205–220 (1973); D.H.Vitt, The genus *Macrocoma* I. Typification of names and taxonomy of the species, *Bryologist* 83: 405–436 (1980); D.H.Vitt, The genus *Macrocoma* II. Geographical variation in the *Macrocoma tenue-M. sullivantii* species complex, *Bryologist* 83: 437–450 (1980); D.G.Catcheside, *Mosses of South Australia* 211–213 (1980); D.H.Vitt, Populational variation and speciation in austral mosses, *J. Hattori Bot. Lab*. 52: 153–159 (1982); D.H.Vitt & H.P.Ramsay, The *Macromitrium* complex in Australasia (Bryopsida: Orthotrichaceae) Part I.

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[2] c/- National Herbarium of New South Wales, Royal Botanic Gardens and Domain, Mrs Macquaries Road, Sydney, New South Wales 2000.

Taxonomy and phylogenetic relationships, *J. Hattori Bot. Lab.* 59: 325–451 (1985); H.P.Ramsay & D.H.Vitt, The *Macromitrium* complex in Australasia (Bryopsida: Orthotrichaceae) Part III. Cytotaxonomy, *J. Hattori Bot. Lab.* 61: 1–43 (1986); P.M.Eckel, The gender of *Macrocoma* Grout is feminine, not neuter, *J. Bryol.* 22: 72–73 (2000).

Macrocoma tenuis (Hook. & Grev.) Vitt, *Rev. Bryol. Lichénol.* 39: 217 (1973)

subsp. **tenuis**

Orthotrichum tenue Hook. & Grev., *Edinburgh J. Sci.* 1: 120 (1824); *Macromitrium tenue* (Hook. & Grev.) Brid., *Bryol. Univ.* 1: 740 (1826). T: Cape of Good Hope, [South Africa], *A.Menzies* & *W.J.Burchell*; lecto: BM, *fide* D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab.* 59: 429 (1985); isolecto: BM, E; syn: BM.

Macromitrium eucalyptorum Müll.Hal. & Hampe, *Linnaea* 26: 500 (1855). T: Bunyip Ck, Vic., *F.Mueller s.n.*; lecto: BM, *fide* D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab.* 59: 429 (1985); isolecto: NY.

Macromitrium johnsonii Hampe, *Linnaea* 40: 308 (1867), *nom. nud.* (in synon.).

Macromitrium geheebii Müll.Hal., *in* G.Hampe, *Linnaea* 40: 308 (1876). T: Illawarra, N.S.W., 1875, *Johnson s.n.*; lecto: BM, *fide* D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab.* 59: 429 (1985).

Macromitrium novae-valesiae Müll.Hal., *Hedwigia* 37: 143 (1898). T: N.S.W., locality unknown, 1872, *D.Kayser*; lecto: M, *fide* D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab.* 59: 430 (1985).

Illustrations: D.H.Vitt, *op. cit.* 218, figs 8–10 (1973); G.A.M.Scott & I.G.Stone, *The Mosses of Southern Australia* 235, pl. 44 (1976), as *Macromitrium tenue*; D.G.Catcheside, *Mosses of South Australia* 212, fig. 114 (1980), as *Macromitrium tenue*.

Leaves stiffly erect-imbricate when dry, lanceolate, 0.7–1.0 mm long; apex bluntly acute to obtuse; upper laminal cells uniform, 7–10 µm wide, smooth; basal laminal cells slightly larger and convex or mammillose. Setae c. 10 mm long. Capsules cylindrical, c. 1.2 mm long, 0.5 mm wide, deeply grooved and plicate at the mouth. Peristome rudimentary; exostome reduced to a membrane; endostome a low hyaline papillose membrane. Spores 22–30 µm diam. $n = 11$, *fide* H.P.Ramsay & D.H.Vitt, *J. Hattori Bot. Lab.* 61: 25–26 (1986).

Occurs in southern S.A., Qld, N.S.W., Vic. and Tas.; grows in rainforest margins, and common in wet coastal forests, but found primarily at higher elevations from southern Qld to the Northern Tablelands of N.S.W. Map 82.

S.A.: near summit, Mt Lofty, *D.G.Catcheside 79.111* (AD). N.S.W.: “Demarque”, Mt Wilson, *W.W.Watts 10376* (NSW); Mt Wilson, *W.W.Watts 10310* (NSW); Jenolan Caves, *H.P.Ramsay S1177* (NSW). Vic.: Sherbrooke Forest, Dandenong Ra., 5 May 1951, *J.H.Willis* (MEL).

This moss is light-tolerant, xerotolerant and is adapted to growing on the small branches and trunks of exotic trees and shrubs on the fringes of rainforest. Scott & Stone (*The Mosses of Southern Australia* 232, 1976) reported a form with axillary bulbils from King Is., Bass Strait.

3. MACROMITRIUM

Dale H. Vitt[1] *& Helen P. Ramsay*[2]

Macromitrium Brid., *Muscol. Recent.*, Suppl. 4: 132 (‘1819’) [1818]; from the Greek *macro* (large) and *mitre* (a headband or head-dress), in reference to the shape of the calyptra.

Type: *M. aciculare* Brid. [= *M. pallidum* (P.Beauv.) Wijk & Margad.]

Dioicous, pseudautoicous (phyllodioicous) with epiphytic dwarf males, or autoicous. Plants small to robust. Stems prostrate to ascending, with erect to ascending branches, forming spreading mats on trees, sometimes on rock, dull or glossy to lustrous, green to olive-green

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or rusty brown above, bright green, yellow-orange or golden-brown below, with a dark brown tomentum. Rhizoids smooth. Stem and branch leaves similar or different. Branch leaves variously crisped, twisted-contorted or spirally twisted around the branch when dry, spreading when moist, lanceolate to ovate-lanceolate, or ligulate to ligulate-lanceolate, or lingulate, usually unistratose, sometimes bistratose or multistratose in upper part of leaf; apex usually acute to acuminate; costa strong, reaching apex or failing just below apex, or excurrent, rarely with a piliferous hyaline point, the apex occasionally fragile, the abaxial surface with elongate cells exposed along its entire length; upper laminal cells rounded, uni- or pluripapillose, with bulging (mammillose) or smooth walls; mid-laminal cells variable; basal laminal cells often elongate, rectangular, smooth or with a single spiculose papilla. Gemmae rarely present. Perigonial and perichaetial leaves differentiated or not. Calyptra large, not enclosing the capsule at maturity, mitrate, splitting around the base into one or many lobes, conical, ±plicate, smooth, glabrous or hairy. Setae short to long, usually twisted to the left, smooth. Capsules on erect secondary branches, exserted or emergent, ovoid to oblong, cylindrical, ellipsoidal or contracted around the mouth, ribbed or smooth; exothecial cells variable; stomata few to many, superficial, basal on capsule; operculum conico-rostrate. Peristome single, double or absent. Spores unicellular, isomorphic or anisomorphic, papillose.

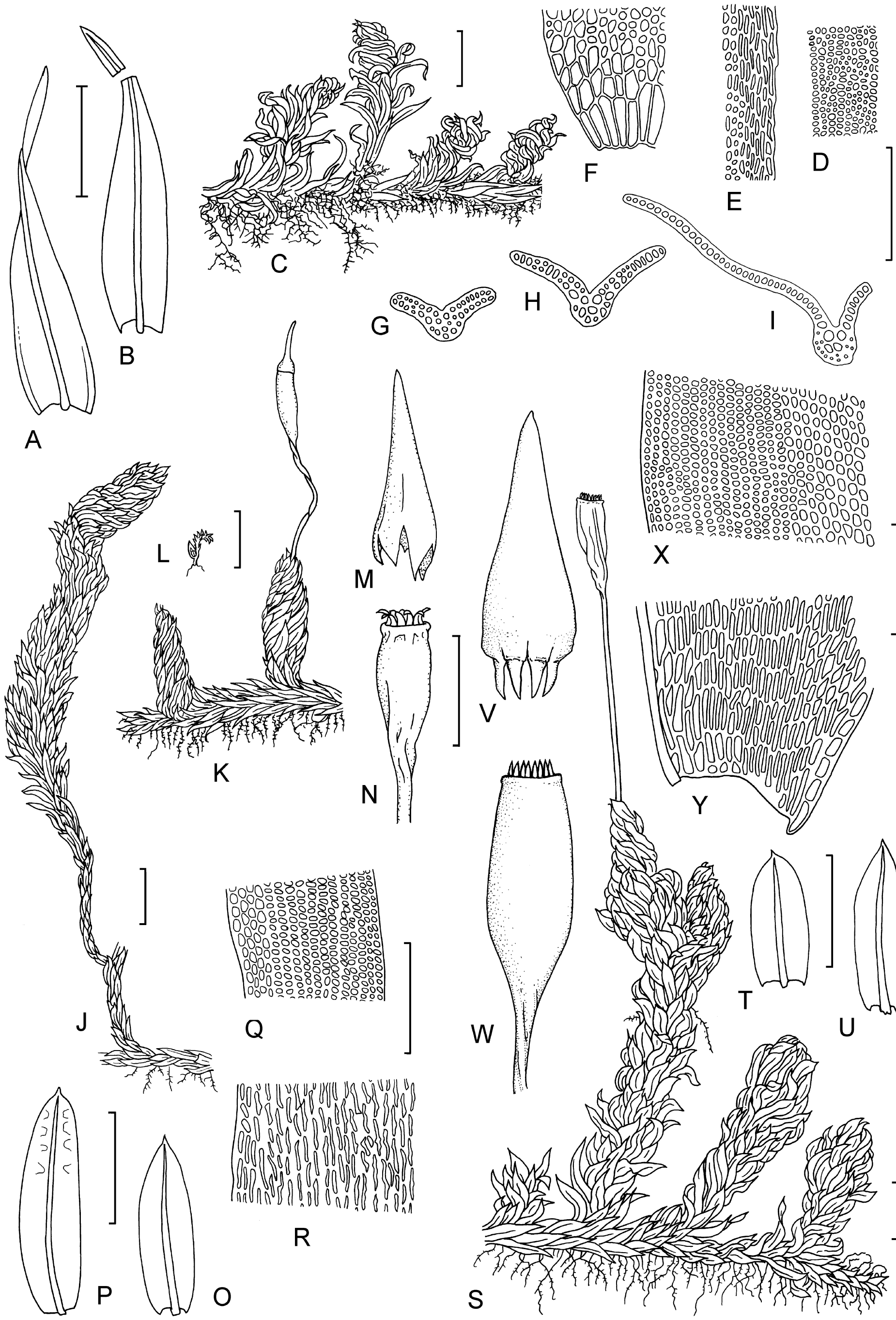
Macromitrium is a large genus of up to 350 species that are widely distributed in tropical and subtropical regions worldwide, but rarer at southern-temperate latitudes. It is represented by 21 species and an additional subspecies in Australia, occuring primarily in the eastern States; 11 species are endemic. One species (*M. archeri*) is known from Western Australia, and the genus is not known from South Australia and the Northern Territory.

Macromitrium occurs in lowland and upland rainforest from sea level to 1500 m and from northern Queensland to Tasmania. The genus is tolerant of dry microhabitats, being adapted to high light intensity and desiccation, with a number of species occurring in the canopy or on the fringes of rainforest. Two species, *M. brevicaule* and *M. longirostre*, occur on coastal rocks, and several have adapted to urban environments being found on the bark of exotic trees in parks or at roadsides.

The genus was divided into five subgenera by Brotherus (*Nat. Pflanzenfam.*, 2nd edn, 11: 10–49, 1925). Subg. *Macrocoma* was raised to generic level by Grout (1946), and all remaining Australian species were placed, by Brotherus, in the very large subg. *Eumacromitrium* (sect. *Goniostoma* and sect. *Leiostoma*). Regional revisions have been provided for New Zealand (Vitt, 1983), Australia (Vitt & Ramsay, 1985a, b) and Papua New Guinea (Vitt *et al.*, 1995). Distinct ‘species groups’ can be recognised among the Australian representatives, although these have not been assigned formal taxonomic status.

A.J.Grout, Bryales: Orthotrichaceae, *North Amer. Fl.* 15A: 1–62 (1946); H.P.Ramsay, Anisospory and sexual dimorphism in the Musci, *in* G.C.S.Clarke & J.G.Duckett (eds), *Bryophyte Systematics*. Systematic Association Special Volume 14: 281–316 (1979); D.H.Vitt, The New Zealand species of the pantropical genus *Macromitrium* (Orthotrichaceae: Musci): Taxonomy, phylogeny and phytogeography, *J. Hattori Bot. Lab.* 54: 1–94 (1983); H.P.Ramsay & D.H.Vitt, Distribution, cytotaxonomy and sexuality of *Macromitrium* in

Figure 20 (opposite). *Groutiella* and *Schlotheimia*. **A–I**, *Groutiella tomentosa*. **A**, Branch leaf; **B**, Branch leaf with caducous tip; **C**, Habit of dry branch (*H.Streimann 29398*, CANB); **D**, Upper laminal cells; **E**, Leaf margin above base; **F**, Laminal cells at insertion, costa at right (*D.Norris 43099*, ALTA); **G–I**, T.S. of leaf from apex to base (A, B, D, E, G–I, *D.Norris 43104*, ALTA). **J–R**, *Schlotheimia brownii*. **J**, **K**, Habit; **L**, Dwarf male plant; **M**, Calyptra; **N**, Capsule; **O**, Branch leaf (*W.W.Watts 534*, NSW); **P**, Perichaetial leaf (*W.W. Watts 534*, NSW); **Q**, Upper laminal cells; **R**, Basal laminal cells (J, K, M, N, *W.Schofield 79059*, NSW; L, Q, R, *H.P.Ramsay s.n.*, NSW). **S–Y**, *Schlotheimia funiformis*. **S**, Habit of dry branch; **T**, Branch leaf; **U**, Perichaetial leaf; **V**, Calyptra; **W**, Capsule; **X**, Upper laminal cells; **Y**, Basal laminal cells (S, U–W, *H.Streimann 29105*, CANB; T, X, Y, holotype). Scale bars: 1 mm for habit and leaves; 100 µm for cellular drawings. Drawn by D.Mackay. A, B, D–I, O–R, T, X, Y redrawn from D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 325–451 (1985) and D.H.Vitt, *Bryologist* 92: 282–298 (1989).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Australasia, *J. Hattori Bot. Lab*. 55: 23–33 (1984); D.H.Vitt & H.P.Ramsay, The *Macromitrium* complex in Australasia (Bryopsida: Orthotrichaceae). Part I. Taxonomy and phylogenetic concepts, *J. Hattori Bot. Lab*. 59: 325–451 (1985a); D.H.Vitt & H.P.Ramsay, The *Macromitrium* complex in Australasia (Bryopsida: Orthotrichaceae). Part II. Distribution, ecology and paleogeography, *J. Hattori Bot. Lab*. 59: 453–468 (1985b); H.P.Ramsay & D.H.Vitt, The *Macromitrium* complex in Australasia (Bryopsida: Orthotrichaceae). Part III. Cytotaxonomy, *J. Hattori Bot. Lab*. 61: 1–43 (1986); D.H.Vitt, T.Koponen & D.H.Norris, Bryophyte flora of the Huon Peninsula, Papua New Guinea LV. *Desmotheca*, *Groutiella*, *Macrocoma* and *Macromitrium* (Orthotrichaceae, Musci), *Acta Bot. Fenn*. 154: 1–94 (1995).

1 Branch leaves ending in a piliferous hyaline point; upper parts of leaves bistratose to multistratose .... **6. M. diaphanum**

1: Branch leaves ending in a non-hyaline cusp, apiculus or mucro, acute, obtuse or acuminate; upper parts of leaves usually unistratose 2

2 Branch leaves spirally twisted, erect-curved or erect-whorled around the branch when dry *(1:)* 3

2: Branch leaves funiculate (rope-like) and arranged in spirals or not; individual leaves twisted-flexuous; apices decurved to recurved-twisted or tightly inrolled when dry 7

3 Branch leaves spirally twisted around the branch, with apices twisted outward when dry; setae thick, twisted to the right *(2)* .... **17. M. longirostre**

3: Branch leaves erect-curved or erect-whorled around the branch, with apices straight or incurved when dry; setae thin, twisted to the left 4

4 Upper laminal cells smooth; branch leaves erect-curved when dry, with the leaf apex sharply contracted to a cusp; costa ending below apex *(3:)* .... **19. M. repandum**

4: Upper laminal cells papillose; branch leaves tightly spirally twisted or erect-whorled when dry; leaf apex mucronate; costa excurrent 5

5 Basal laminal cells short, rounded to elliptical; fusiform gemmae frequent *(4:)* .... **4. M. brevicaule**

5: Basal laminal cells rectangular; gemmae absent 7

6 Branch leaves twisted-curved; basal laminal cells smooth; seta short (< 1.3 mm); capsule ±immersed in the perichaetium *(5:)* .... **3. M. brachypodium**

6: Branch leaves erect-whorled; basal laminal cells papillose-tuberculate; seta longer (3–7 mm); capsules exserted .... **2. M. aurescens**

7 Upper branch leaf cells smooth and flat, sometimes slightly bulging or mammillose, rarely with 1 or more small papillae *(2:)* 8

7: Upper branch leaf cells uni- or pluripapillose; papillae large and obvious or, if small and inconspicuous, the walls strongly bulging 11

8 Branches to 10 mm long; branch leaves 1.2–2.0 mm long; basal laminal cells evenly thickened, elongate-rectangular with straight lumina; all cells smooth; autoicous *(7)* 9

8: Branches to 32 mm long; branch leaves 1.5–3.0 mm long; basal laminal cells unevenly thickened and elongate; lumina rather irregularly curved; some cells with short or long papillae; dioicous, pseudautoicous or sex unknown 10

9 Branch leaves gradually narrowed to a long decurved subulate arista entirely composed of costa *(8)* .... **7. M. dielsii**

9: Branch leaves abruptly narrowed to an acute or short-acuminate apex (some leaves short-cuspidate); costa ending in the apex or short-excurrent .... **18. M. microstomum**

10 Branch leaves gradually narrowed to a long-acuminate apex; costa excurrent and forming the acumen; pseudautoicous *(8:)* .... **9. M. funiforme**

10: Branch leaves abruptly narrowed to an acute or short-cuspidate apex; costa ending in the cusp or apex, rarely excurrent .... **8. M. exsertum**

11 Branch leaves lanceolate *(7:)* 12

11: Branch leaves oblong to ligulate, sometimes with a broader ±ovate base 16

12 Upper laminal cells bordering the costa flat, smooth and elongate, strongly differentiated from remainder of quadrate densely papillose upper cells *(11)* .... **21. M. subulatum**

12: Upper laminal cells bordering the costa quadrate, densely papillose, similar to remainder of upper cells 13

13 Mid-leaf and basal cells smooth; calyptra glabrous or hairy; cells in upper half of leaf in distinct longitudinal rows *(12:)*..14

13: Mid-leaf cells bulging or unipapillose; many basal cells with a short or spiculose papilla; calyptra hairy; cells in upper half of leaf usually not in longitudinal rows...15

14 Calyptra densely hairy; perichaetial leaves much shorter than vegetative branch leaves, lingulate, inconspicuous; cells at mid-leaf ±short-rectangular, with straight lumina *(13)* ....**12. M. incurvifolium**

14: Calyptra glabrous to sparsely hairy; perichaetial leaves much longer than vegetative branch leaves, erect, sheathing the seta; cells at mid-leaf rectangular with curved lumina....................**14. M. leratii**

15 Upper branch leaf cells bulging, weakly pluripapillose; cells at mid-leaf short-rectangular, bulging; rusty brown tones evident in young growth; perichaetial leaves erect, sheathing, strongly differentiated *(13:)* ....**20. M. stoneae**

15: Upper branch leaf cells densely pluripapillose; cells at mid-leaf rectangular, strongly unipapillose; golden tones evident in young growth; perichaetial leaves ±erect-curved, subsheathing, scarcely differentiated ....**10. M. hemitrichodes**

16 Upper branch leaf cells strongly bulging-conical, unipapillose; marginal cells smaller than those near the costa; mid-leaf cells strongly unipapillose; basal cells elongate, those at the very base smooth; capsules 4–8-plicate on a very long slender seta; branch leaves twisted-decurved; peristome absent or fragmentary *(11:)* ....**1. M. archeri**

16: Upper branch leaf cells bulging, smooth to low-pluripapillose; marginal cells similar in size to those near the costa; mid-leaf cells bulging and low-papillose; basal cells rectangular to elongate, those at the very base smooth; capsules 8-plicate or with a distinct darkened non-plicate often collapsed rim; setae short or long; branch leaves twisted-inrolled; peristome present or absent.............................17

17 Capsules cylindrical, on short setae, emergent to short-exserted; plants robust; mature branches often detached from stem; calyptra densely hairy *(16:)* ....**13. M. involutifolium**

17: Capsules ovate to elliptic-oblong, on long setae, long-exserted; plants slender; branches remaining attached to stem; calyptra glabrous or with a few hairs 18

18 Peristome a low basal membrane; capsule rim 8-plicate *(17:)*..19

18: Peristome of 16 erect teeth; capsule rim collapsed or erect, never 8-plicate 20

19 Autoicous; branch leaves broadly ligulate, the upper portions strongly inrolled, with most apices hidden in leaves, obtuse or broadly acute; costa usually ending below the apex *(18)* ....**5. M. caloblastoides**

19: Pseudautoicous; branch leaves narrowly ligulate, the upper portions somewhat inrolled; most apices rather exposed to one side of leaf, acute to apiculate; costa short-excurrent in most populations.. **15. M. ligulaefolium**

20 Capsule mouth collapsed; exothecial cells of rim elongate; calyptra lobed at base to cucullate, usually with 1–4 slits *(18:)*..**16. M. ligulare**

20: Capsule mouth erect; exothecial cells of rim rounded-quadrate; calyptra deeply lobed to just below the rostrum, with 10–15 slits ....**11. M. hortoniae**

1. Macromitrium archeri Mitt., *in* J.D.Hooker, *Fl. Tasman*. 2: 183 (1859)

T: Cheshunt, Tas., [*W.*]*Archer*; lecto: NY, *fide* D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 406 (1985); isolecto: MEL; Kermandie Rivulet, Tas., *A.F.Oldfield*; syn: NY.

Macromitrium pusillum Mitt., *in* J.D.Hooker, *Fl. Tasman*. 2: 183 (1859). T: Cataract Hill, Tas., *W.Archer*; holo: NY.

Macromitrium asperulum Mitt., *in* J.D.Hooker, *Fl. Tasman*. 2: 376 (1859). T: locality unknown, Tas., [*R.W.*?]*Lawrence*; lecto: NY, *fide* D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 406 (1985); *loc. id.*, *R.C.Gunn*; syn: NY.

Macromitrium muelleri Hampe, *Linnaea* 30: 634 (1860). T: Sealers Cove, Vic., *coll. unknown*; lecto: BM, *fide* D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 406 (1985); isolecto: BM.

Macromitrium fimbriatum Hook.f. & Wilson ex Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 100 (1906), *nom. nud.* (in synon.).

Illustrations: D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 407, figs 239–241; 408, figs 250–251, 253, 255–256 (1985).

Pseudautoicous. Plants small, dull, orange-green to dark golden-green above, darker below; branches slender, to 10 mm tall. Branch leaves irregularly twisted-curved to loosely curved around the branch, not inrolled or funiculate when dry, straight and spreading when moist, ligulate to linear-lanceolate, 1.4–1.8 mm long, weakly keeled; apex acute to apiculate-acuminate; margin plane or slightly reflexed, entire; costa excurrent, filling apiculus; upper laminal cells rounded-quadrate, 9–13 µm wide near costa, elliptical and c. 7 µm wide at margin, strongly bulging with a large conical central papilla, less bulging at margin; mid-laminal cells strongly bulging, rhomboidal to rectangular, 14–25 × 10–12 µm, thick-walled, with straight to ±curved lumina, sometimes with a central papilla; basal cells flat, elongate, 12–40 × 5–7 µm, thick-walled, smooth. Perichaetial leaves inconspicuous, erect, stiff, ovate, 1.4–1.6 mm long, with a short-acuminate apex; costa ending in apex or short-excurrent; laminal cells similar to those of vegetative leaves but less papillose and longer above. Calyptra narrowly conical, evenly lacerate below, faintly plicate, smooth, glabrous. Setae erect, slender, 2.8–8.0 mm long. Capsules long-exserted, ovoid, 1.2–2.0 mm long, 4-angled to slightly 8-plicate just below the mouth, smooth but with a long wrinkled neck. Peristome absent or fragmentary. Spores distinctly anisomorphic, 15–29 µm diam. n = 9, *fide* H.P.Ramsay & D.H.Vitt, *J. Hattori Bot. Lab*. 61: 22–23 (1986). Plates 19, 20.

This endemic moss is abundant only in Tas.; it also occurs in south-western W.A. (the only Macromitrium known from that State), eastern Qld, eastern N.S.W. and Vic. An epiphyte on tree trunks and canopy branches in tropical and cool-temperate rainforest. Map 83.

W.A.: Castle Rock, Porongurup Natl Park, *R.Wyatt & A.Stoneburner 4354* (PERTH). Qld: E slope of Thornton Peak, *D.H.Norris 44008* (NSW). N.S.W.: Currembene Ck, *W.B.Schofield 79101* (NSW). Vic.: Gildberg, Feb. 1908, *J.R.Murdock* (NSW). Tas.: L. Barrington, near Forth Falls, *D.H.Norris 27308* (HO).

Macromitrium archeri is characterised by capsules that are 4-angled to slightly 8-plicate just below the mouth, upper and mid-laminal cells with single, strongly conical papillae, smooth basal cells, strongly apiculate branch leaves, orange-green colouration and the glabrous calyptra.

2. **Macromitrium aurescens** Hampe, *Linnaea* 30: 633 (1860)

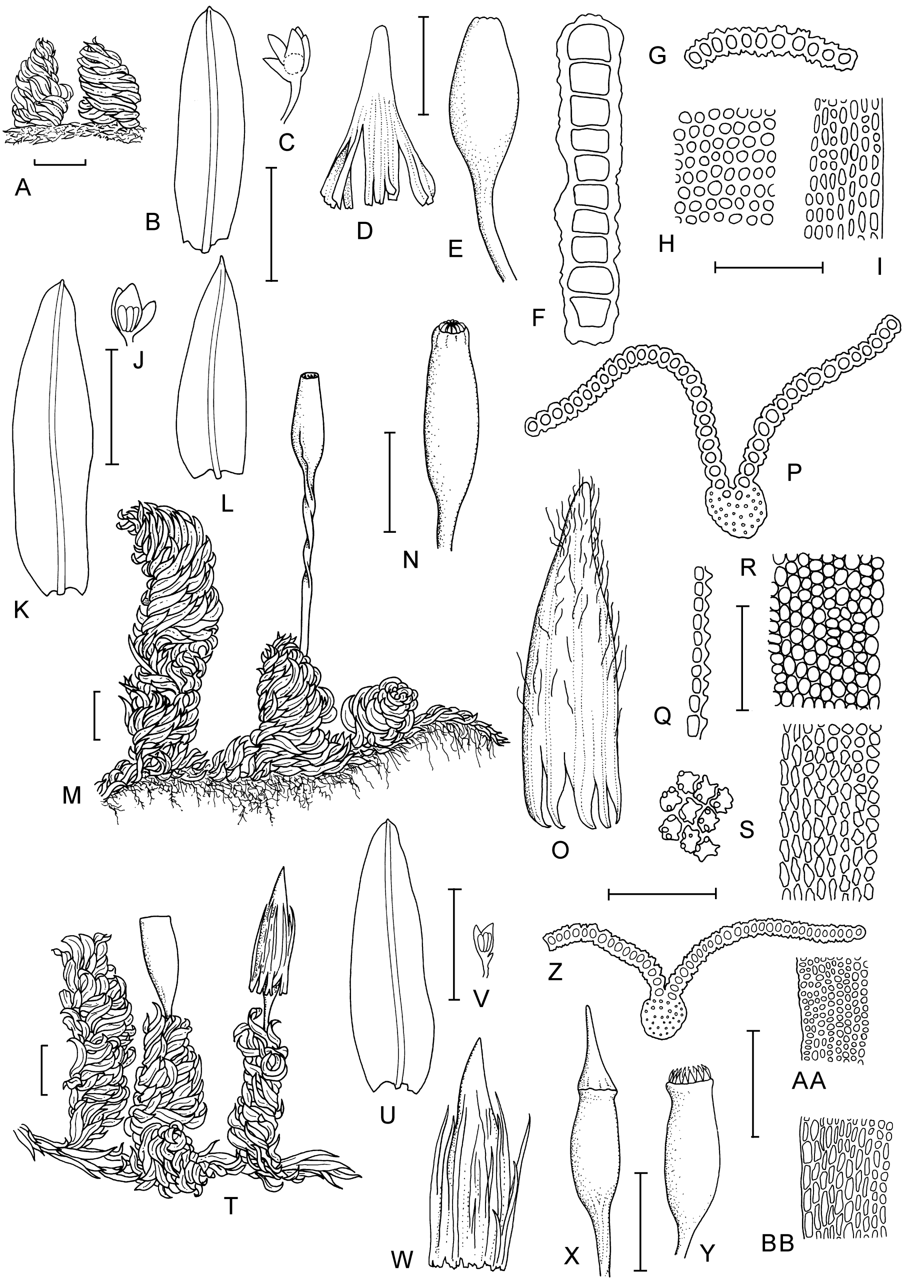
T: Delabechiam, Keppel Bay, Qld, *F.Mueller*; holo: not located; iso: H-BR, MEL, NSW.

Macromitrium sordide-virens Müll.Hal., *Linnaea* 37: 153 (1872). T: Brisbane R., Qld, 1864, *A.Dietrich*; lecto: H-BR, *fide* D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 383 (1985); isolecto: MEL.

Macromitrium cylindromitrium Müll.Hal., *Hedwigia* 37: 146 (1898). T: Ennogera, Qld, *F.M.Bailey s.n.*, in Herb. Brotherus 1890; lecto: H-BR, *fide* D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 383 (1985); isolecto: MEL, NSW; Wide Bay, Gayndah, Qld, 1874, *E.Daemel s.n.*, in Herb. Godeffroy, Hamburg; syn: H-BR.

Illustrations: D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 384, figs 152–162; 386, figs 164–168 (1985).

Figure 21 (opposite). *Macromitrium*. **A–I**, *M. brevicaule*. **A**, Habit of dry branch (*C.Wild*, NSW M12729); **B**, Branch leaf (*Moore 1937*, WELT); **C**, Dwarf male plant (*H.P.Ramsay 1/76*, NSW); **D**, Calyptra (*Turbott 1946*, WELT); **E**, Capsule (*Moore 1937*, WELT); **F**, Gemma (*W.W.Watts 1041*, NSW); **G**, T.S. upper laminal cells (*W.W.Watts s.n.*, isosyntype, WELT); **H**, Upper laminal cells (*Moore 1937*, WELT); **I**, Basal laminal cells (*Moore 1937*, WELT). **J–S**, *M. aurescens*. **J**, Dwarf male plant (*F.Whitteron*, Dec. 1900, NSW); **K**, Branch leaf (*D.H.Vitt 28186*, ALTA); **L**, Perichaetial leaf (*I.G.Stone 17907*, ALTA); **M**, Habit of dry branch (*J.Windolf 1122*, NSW); **N**, Capsule (*J.Windolf 1122*, NSW); **O**, Calyptra (*J.Windolf 1114*, NSW); **P**, T.S. upper laminal cells (*D.H.Vitt 28118*, ALTA); **Q**, L.S. basal laminal cells (*D.H.Vitt 28118*, ALTA); **R**, Upper laminal cells (*D.H.Vitt 28114*, ALTA); **S**, Basal laminal cells (right), and papillae on those cells (left) (*D.H.Vitt 28118*, ALTA). **T–BB**, *M. brachypodium*. **T**, Habit of dry branch (*W.W.Watts LHI 41*, NSW); **U**, Branch leaf (*D.H.Vitt 28552*, ALTA); **V**, Dwarf male plant (*H.P.Ramsay 45/81*, NSW); **W**, Calyptra (*W.W.Watts LHI 41*, NSW); **X**, Capsule with operculum (*D.H.Vitt 28321*, ALTA); **Y**, Capsule showing peristome (*W.W.Watts LHI 41*, NSW); **Z**, T.S. upper laminal cells (*D.H.Vitt 28621*, ALTA); **AA**, Upper leaf cells (*D.H.Vitt 28560*, ALTA); **BB**, Basal laminal cells (*D.H.Vitt 28560*, ALTA). Scale bars: 1 mm for habit and leaves; 100 µm for cellular drawings. Drawn by D.Mackay. B–I, K, L, N–S, U–BB redrawn from D.H.Vitt, *J. Hattori Bot. Lab*. 54: 1–97 (1983) and D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 325–451 (1985).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Pseudautoicous. Plants medium-sized to large, robust, dull, pale green above, dark brown below. Stems with dense stout erect-curved branches to 10 mm tall. Branch leaves irregularly erect-curved to twisted-decurved, stiffly and spirally twisted to spirally whorled around the branches when dry, erect-spreading when moist, oblong, very strongly keeled, conduplicate, 2.0–2.6 mm long; apex stoutly mucronate; mucro hooked, cucullate; costa very conspicuous, strong, excurrent in the mucro; upper laminal cells bulging, rounded-quadrate, 7–13 µm wide, papillose, with 3–5 small conical to forked papillae per cell; mid-laminal cells rounded to elliptical, more elongated towards the base, 9–11 µm wide, with 1 or 2 conical to forked papillae per cell; basal laminal cells restricted to 3–7 tiers at insertion, flat, short-rectangular, 15–35 × 10–15 µm, smooth; marginal cells longer. Perichaetial leaves short, inconspicuous. Calyptra slender-conical, evenly split 1/3–1/2, plicate, smooth, densely hairy with fine long-flexuose hyaline hairs. Setae flexuose-erect, slender, 3.2–7.0 mm long. Capsules short-exserted, cylindrical, 1.9–3.0 mm long. Peristome single; exostome teeth 16, well developed, erect-curved, linear-lanceolate, finely papillose; endostome absent. Spores anisomorphic, 15–34 µm diam., finely papillose. Chromosome number not known. Fig. 21J–S.

Endemic to north-eastern Australia; common north of Townsville, but also extending south and inland from the coast into northern N.S.W. Frequent, especially on rough bark; occurs in gallery forests dominated by *Melaleuca* spp., *Grevillea robusta* and *Casuarina* species. Map 84.

Qld: Coolum, *J.Windolf 1114* (BRI); Keppel Bay, *F.Mueller* (NSW); Ravenshoe, *D.H.Norris 42381* (NSW); Mt Lindesay, *P.I.Forster PIF 2405* (BRI). N.S.W.: 37 km S of Gloucester, *H.Streimann 43950* (CANB).

Macromitrium aurescens is closely related to *M. brevicaule*; both have leaves that are broad, oblong, conduplicate, mucronate with conspicuous costae, and have densely papillose upper laminal cells and short basal cells. It is readily distinguished from all other species by the conduplicate leaves that are whorled when dry, each leaf having a hooked, cucullate mucro. Unlike *M. brevicaule*, it lacks gemmae, and its distribution differs from that of *M. brachypodium*, a common species in Lord Howe Is., but known from only one collection in north-eastern Qld.

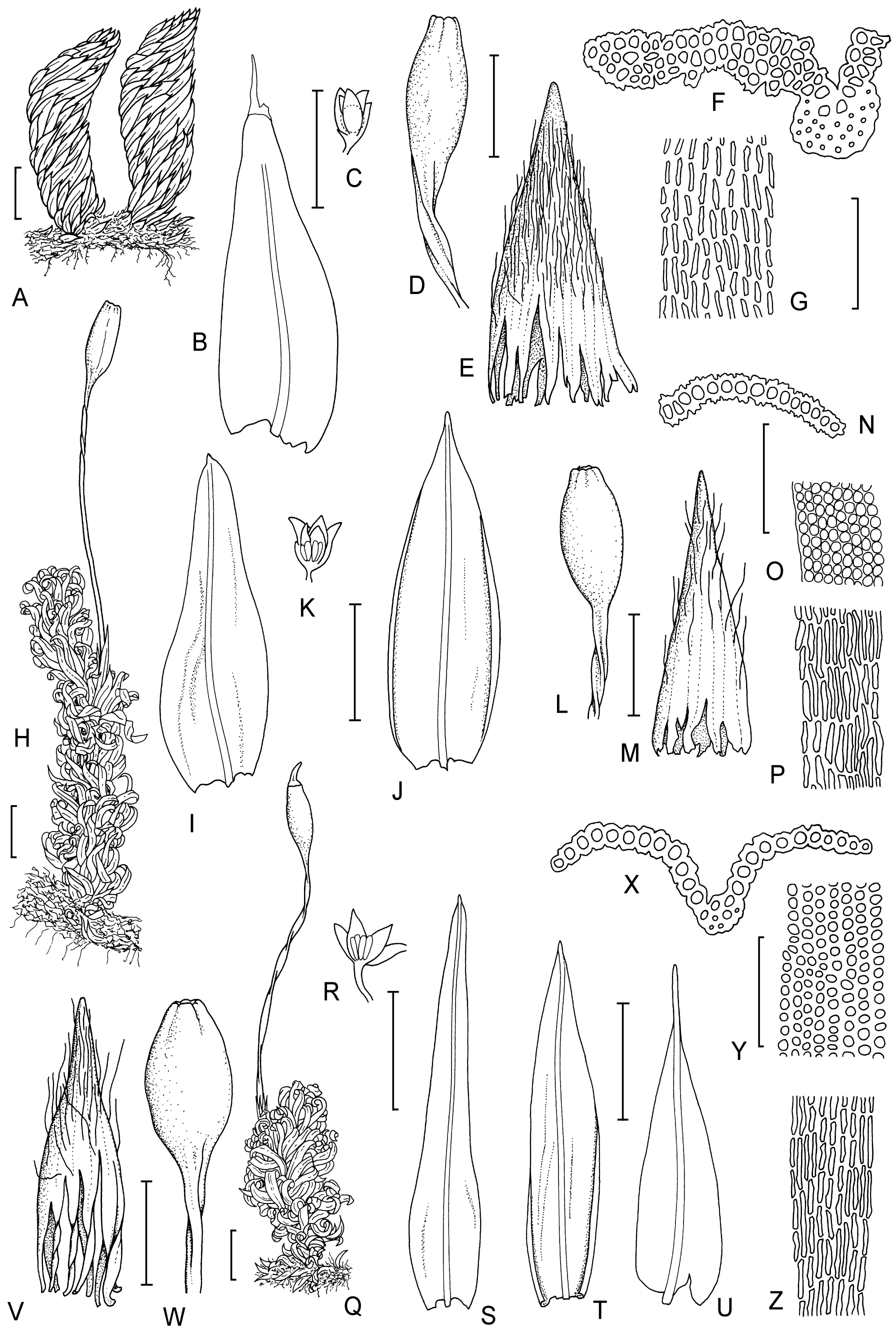
3. Macromitrium brachypodium Müll.Hal., *Bot. Zeitung (Berlin)* 15: 778 (1857)

T: Île des Pins, New Caledonia, *Cuming*; lecto: H-BR, *fide* D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 387 (1985).

Illustrations: D.H.Vitt & H.P.Ramsay, *op. cit.* 389, figs 171–180; 390, figs 181–186 (1985).

Dioicous (pseudautoicous with dwarf males). Plants small, in dense spreading mats. Stems slender, with branches to 5 mm long, simple or branched, olive-green above, dark brown below. Branch leaves twisted-contorted, somewhat curved around the branch when dry, straight and erect-spreading when moist, oblong-ligulate, 1.5–2.5 mm long; apex obtuse to mucronate; margin plane; costa strong, ending in the apex; upper laminal cells broad, rounded,

Figure 22 (opposite). *Macromitrium*. **A–G**, *M. diaphanum*. **A**, Habit of dry branch (*W.W.Watts 4064*, NSW); **B**, Branch leaf (*D.H.Norris 38435*, ALTA); **C**, Dwarf male plant (*W.W.Watts 4064*, NSW); **D**, Capsule (*C.J.Wild 1887*, BRI); **E**, Calyptra (*Barclay 52*, NY); **F**, T.S. upper laminal cells (*D.H.Norris 38435*, ALTA); **G**, Basal laminal cells (*D.H.Norris 38435*, ALTA). **H–P**, *M. hemitrichodes*. **H**, Habit of dry branch (*H.P.Ramsay 7510*, NSW); **I**, Branch leaf (*D.H.Vitt 27191*, ALTA); **J**, Perichaetial leaf (*D.H.Vitt 27401*, ALTA); **K**, Dwarf male plant (*H.P.Ramsay 11/80*, NSW); **L**, Capsule (*D.H.Vitt 27191*, ALTA); **M**, Calyptra (*D.H.Vitt 27401*, ALTA); **N**, T.S. upper laminal cells (*D.H.Vitt 27401*, ALTA); **O**, Upper laminal cells (*D.H.Vitt 27191*, ALTA); **P**, Basal laminal cells (*D.H.Vitt 27191*, ALTA). **Q–Z**, *M. stoneae*. **Q**, Habit of dry branch (*D.H.Vitt 27575*, ALTA); **T**, Outer perichaetial leaf (*D.H.Vitt 27575*, ALTA); **U**, Inner perichaetial leaf (*D.H.Vitt 27483*, ALTA); **V**, Calyptra (*D.H.Vitt 28154*, ALTA); **W**, Capsule (*D.H.Vitt 27522*, ALTA); **X**, T.S. upper laminal cells (*D.H.Vitt 27575*, ALTA): **Y**, Upper laminal cells (*D.H.Vitt 27575*, ALTA); **Z**, Basal laminal cells (*D.H.Vitt 27575*, ALTA). Scale bars: 1 mm for habit and leaves; 100 µm for cellular drawings. Drawn by D.Mackay. B, D–G, I, J, L–P, S–Z redrawn from D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 325–451 (1985).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somewhat bulging, 7–9 µm wide, unistratose, with small low irregular papillae; basal laminal cells rectangular near insertion, 10–13 × 5–7 µm, smooth, flat, longer near the margin and forming a distinct border of 5–10 rows. Perichaetial leaves ligulate-oblong, 2.5–2 mm long. Calyptra mitrate, short-conical, fimbriate-lacerate, smooth, plicate, glabrous. Setae short, to 1.3 mm long. Capsules emergent to short-exserted, oblong, 1.7–2.0 mm long, smooth. Peristome single; exostome teeth 16, linear-lanceolate; endostome absent. Spores anisomorphic, 14–29 µm diam. n = 8 (Lord Howe Is.), *fide* H.P.Ramsay & D.H.Vitt, *J. Hattori Bot. Lab*. 61: 41 (1986). Fig. 21T–BB.

In mainland Australia, known only from a single collection near Townsville, north-eastern Qld. Also in Lord Howe Is. and New Caledonia. Map 85.

Qld: Mt Elliot, near Townsville, *coll. unknown* (BM).

Macromitrium brachypodium is distinguished from other Australian species by the densely papillose upper laminal cells, the short, smooth basal cells, short setae and capsules that are small, immersed to slightly emergent, smooth, non-plicate and with a gaping mouth when dry.

Its occurrence in mainland Australia has yet to be confirmed, and recent efforts to re-collect this species in the Townsville area have not been successful.

4. Macromitrium brevicaule (Besch.) Broth., *Nat. Pflanzenfam*. I, 3: 486 (1903)

Micromitrium brevicaule Besch., *Ann. Sci. Nat. Bot*., sér. 5, 18: 211 (1873). T: Balade, [New Caledonia], *Vieillard 1734*; lecto: BM, *fide* D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 381 (1985); Noumea, [New Caledonia], *Balansa 2563*; syn: BM.

Macromitrium wattsii Broth., *Oefvers. Förh. Finska Vetensk.-Soc*. 40: 81 (1898). T: E of Balina [Ballina], N.S.W., *W.W.Watts 329*; lecto: H-BR, *fide* D.H.Vitt, *J. Hattori Bot. Lab*. 54: 65 (1983); isolecto: NSW; *loc. id*., *W.W.Watts 719*, *1041*; North Ck, N.S.W., *W.W.Watts 1108*; Wollongong, N.S.W., *W.W.Watts 109*; syn: H-BR, *fide* D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 406 (1985); isosyn: NSW (*W.W.Watts 719*, *109*).

Macromitrium mucronulatum Müll.Hal., *Hedwigia* 37: 146 (1898). T: Burpengary, Qld, 1888, *C.Wild*, in Herb. Brotherus; holo: H-BR; iso: NSW.

Illustrations: D.H.Vitt, *J. Hattori Bot. Lab*. 54: 54, figs 145, 149–150; 66, figs 179–188 (1983); H.Streimann, *The Mosses of Norfolk Island* 115, fig. 51 (2002).

Pseudautoicous. Plants slender, pale yellow-green above, dull green below; branches to 3 (–7) mm tall. Stem leaves erect-twisted when dry, spreading when moist, ovate-lanceolate, 0.8–1.0 mm long, without a differentiated border; apex bluntly acute or obtuse; upper laminal cells low-papillose; basal laminal cells rounded, smooth, clear. Branch leaves conduplicate, spirally arranged, stiffly flexuose when dry, erect-spreading, straight with a reflexed apex when moist, oblong, strongly keeled, 1.0–1.8 mm long; apex obtuse, often mucronate; costa excurrent in a mucro or ending just below the apex, smooth; upper laminal cells bulging, subquadrate, 8–12 µm wide, thin-walled, obscured by low dense simple or forked papillae, with 1 or 2 rows of low-papillose or smooth marginal cells; mid-laminal cells similar; interior basal laminal cells flat, 16 × 4–6 µm; cells nearer margin 10–24 × 5–10 µm, ±hyaline, forming an indistinct border. Fusiform gemmae on leaves, cylindrical, 8–15 cells long; outer walls coarsely and irregularly papillose. Calyptra covering c. half of urn, fimbriate, short-lacerate with age, smooth, glabrous. Perichaetial leaves undifferentiated. Setae 3–5 mm long. Capsules exserted, narrowly ovoid, 1.3–1.7 mm long, smooth, with 8 ribs below the small mouth. Peristome single; exostome teeth 16, erect to inflexed, irregular, 60–160 µm long, blunt, finely papillose; endostome absent. Spores slightly anisomorphic, 18–20 and 20–25 µm diam., thick-walled, finely papillose to smooth. n = 10 (Norfolk Is.), *fide* H.P.Ramsay & D.H.Vitt, *J. Hattori Bot. Lab*. 61: 19 (1986). Fig. 21A–I.

Occurs on the eastern coast of Australia from central Qld to south-eastern N.S.W.; also in Lord Howe Is., Norfolk Is., northern New Zealand and New Caledonia. Restricted to rocks and tree trunks subject to salt spray in coastal habitats; occurs as large populations on tree trunks in closed forest behind the sand dune-beach zone and on cliff faces in protected situations. Map 86.

Qld: Burpengary Is., *C.J.Wild* (NSW). N.S.W.: East Ballina, *W.W.Watts 719* (NSW); Manly, Sydney, *W.W.Watts 4282* (NSW).

This moss is readily distinguished by the very short, erect branches, the stiff, flexuose, spirally arranged branch leaves that are broad and oblong with mucronate apices, and by the strong, conspicuous costae. The combination of low-pluripapillose upper laminal cells and short basal laminal cells distinguishes this from most Australian species, with the exception of *M. aurescens*. However, the latter has hairy rather than glabrous calyptrae as in *M. brevicaule*. Leaf gemmae are frequent on specimens of *M. brevicaule*; the only other Australian species having these structures (but only rarely) is *M. ligulaefolium*.

5. Macromitrium caloblastoides Müll.Hal., *Hedwigia* 37: 151 (1898)

T: locality unknown, Qld, *F.M.Bailey*; holo: H-BR; iso: NSW.

Macromitrium dimorphum Müll.Hal., *Hedwigia* 37: 152 (1889). T: locality unknown, Qld, 1888, *F.M.Bailey*; holo: H-BR.

Illustrations: D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 358, figs 73–83; 359, figs 84–89 (1985).

Autoicous. Plants slender, very dull, pale green above, darker green-brown below. Stems with short erect branches to 5 (–10) mm tall. Branch leaves spreading-curved, upper portion strongly and tightly inrolled when dry with apices hidden, flexuose-spreading with cucullate incurved apices when moist, very strongly keeled, broadly ligulate to oblong, 1.5–2.5 mm long; apex bluntly and broadly acute; margin broadly reflexed, entire below, minutely crenulate above; costa ending in or just below apex; upper laminal cells strongly bulging, rounded, 9–12 µm wide, thin-walled, with thickened corners, smooth or sometimes with 1–4 small papillae, the cells uniform across leaf, more than 18 cell rows from costa to margin; mid-laminal cells in longitudinal rows, strongly bulging, rounded to elliptical, 10–12 µm wide, smooth; basal laminal cells smooth or somewhat bulging, elongate-rectangular, 14–35 × 7–10 µm, lumina rather irregularly curved, unevenly thickened, sometimes with a single low papilla. Calyptra broadly conical, gradually contracted to the rostrum, plicate, divided into several fine lobes, glabrous. Perigonia on short branches near the perichaetia. Perichaetial leaves curved-erect to loosely but stiffly erect, ovate-lanceolate to oblong, 1.2–1.5 mm long, with an acuminate to acute apex. Setae stiffly flexuose to erect, thin, twisted to the left, 5–7 mm long. Capsules long-exserted, ovoid to oblong-ellipsoidal, 1.0–1.5 mm long, smooth, 8-plicate below the narrowed puckered mouth, darker below and at the rim. Peristome single, greatly reduced or absent; exostome a low papillose membrane 1–few cells high; teeth 16, inconspicuous; endostome absent. Spores isomorphic, 18–28 µm diam., finely papillose. $n = 11$, *fide* H.P.Ramsay & D.H.Vitt, *J. Hattori Bot. Lab*. 61: 16–17 (1986).

Endemic to eastern Australia, from north-eastern Qld to south-eastern N.S.W.; most common in south-eastern Qld and north-eastern N.S.W. Never abundant, it occurs in drier gallery forest dominated by *Eucalyptus*, *Casuarina* and *Leptospermum*. In many areas it is ecologically isolated from its sister species *M. ligulaefolium* and is not part of the ravine rainforest vegetation. Map 87.

N.S.W.: Ballina, *W.W.Watts 4025* (NSW); Teven, *W.W.Watts 4287* (NSW); Victoria Park, Alstonville, *H.P.Ramsay 35/81* (NSW).

Distinguished by being autoicous, with branches to 10 mm tall, broadly ligulate to oblong, bluntly cucullate leaves that are tightly inrolled with hidden apices, capsules that are puckered at the mouth and distinctly 8-plicate, a peristome that is single, greatly reduced or absent, and isomorphic spores.

6. Macromitrium diaphanum Müll.Hal., *Linnaea* 37: 151 (1872)

T: Brisbane R., [Qld], 1861, *A.Dietrich*; neo: NY, *fide* D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 391 (1985).

Macromitrium circinicladum Müll.Hal., *Hedwigia* 37: 145 (1898). T: Richmond R., N.S.W., 1880, *Miss Hodgkinson*, in Herb. Melbourne; holo: (not located in MEL); iso: H-BR.

Illustrations: D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 393, figs 188–196; 408, figs 252, 254 (1985).

Pseudautoicous. Plants slender, dull, silvery green, darker below; branches short, simple, to 5 mm tall. Branch leaves erect-curved and somewhat curved around he branch when dry, stiffly spreading when moist, oblong-ovate to oblong-lanceolate, strongly keeled, 2.0–2.5 mm long, strongly reflexed, narrowing to an irregularly notched awned apex, the awn flexuose, broad

below, sometimes broken off, hyaline; costa strong, excurrent, running the length of the awn, smooth; upper laminal cells uni-, bi- or tristratose, bulging, rounded, 10–14 µm wide, thick-walled, irregularly papillose, the papillae pronounced, irregular, forked or simple; mid-laminal cells 8–10 µm wide, unipapillose proximally; basal laminal cells rhomboidal-elongate to rectangular, to 35 µm long, thick-walled, smooth or with occasional scattered tall spiculose papillae, with a basal border of 1 row of shorter broader thin-walled cells. Perichaetial leaves erect, ovate, 2.3–2.5 mm long, ending in a slender awned hyaline apex; upper laminal cells rhomboidal, very thick-walled, smooth; basal cells elongate, continuing higher than in branch leaves. Calyptra 3–4 mm long, with numerous slits, smooth, densely hairy, the hairs slender and flexuose. Setae erect, twisted, 4–8 mm long. Capsules exserted, fusiform-elliptical, 2.0–2.6 mm long, 8-plicate in the upper third; rim darker and narrow. Peristome absent. Spores anisomorphic, 19–50 µm diam., papillose. Chromosome number not known. Fig. 22A–G.

Endemic to eastern Qld and north-eastern N.S.W. (as far south as Taree). A rare species not known from ravine rainforest. It is thought to be xerotolerant, occurring with *M. aurescens* in gallery forest. In the border region of Qld and N.S.W. it often occurs as an epiphyte on *Casuarina cunninghamiana* along streams. Map 88.

Qld: North Toohey Ck, *H.Flecker 3361* (CANB); Proserpine, *H.Streimann 37716* (CANB); Burpengary, Nov. 1887, *C.J.Wild* (BRI); Eungella Dam Rd, near Mackay, *D.H.Norris 38407* (NSW). N.S.W.: near Ballina, *W.W.Watts 4060* (NSW).

Extensive collections were made in north-eastern N.S.W. and south-eastern Qld in the early twentieth century, but it is likely that the destruction of habitat for agriculture may be responsible for its rarity today.

Macromitrium diaphanum is a very distinctive species with leaves ending in a hyaline awn. The awn varies considerably in size and shape, sometimes with 2 or 3 distal projections, sometimes with a principal awn and 1 or 2 accessory hyaline projections. Other diagnostic features are the papillose upper laminal cells, the densely hairy, elongate calyptra, the fusiform, non-peristomate capsule, the unistratose basal laminal cells mostly with a single, tall, spiculose papilla and the silvery green colouration of the plants.

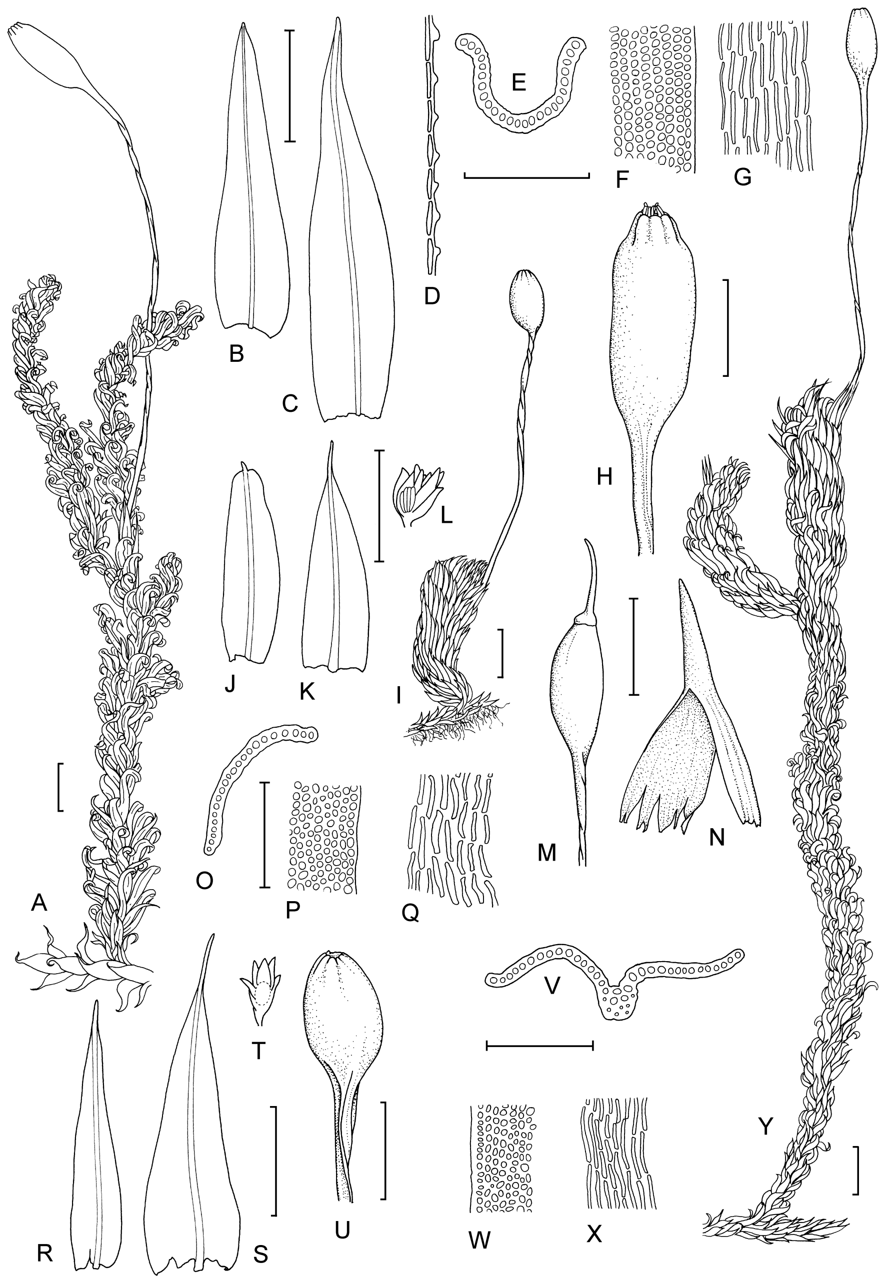
7. Macromitrium dielsii Broth. ex Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 339 (1985)

T: Bellenden Ker Ra., Qld, *D.H.Vitt 27491*; holo: ALTA; iso: NSW.

Illustrations: D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 340, figs 4–14; 342, figs 15–21 (1985).

Autoicous. Plants small, very lustrous, pale golden-green above to dark rusty brown below. Stems creeping, with short erect branches to 5 mm tall. Branch leaves funiculate, in spirals, strongly twisted-contorted when dry, flexuose-spreading when moist, narrowly lanceolate,

Figure 23 (opposite). *Macromitrium*. **A–H**, *M. exsertum*. **A**, Habit of dry branch (*C.Helman*, 1982, NSW); **B**, Branch leaf (*D.H.Vitt 27605*, ALTA); **C**, Perichaetial leaf (*D.H.Vitt 27603*, ALTA); **D**, L.S. of basal laminal cells (*D.H.Vitt 27614*, ALTA); **E**. T.S. of upper laminal cells (*D.H.Vitt 27454*, ALTA); **F**, Upper laminal cells (*D.H.Vitt 27454*, ALTA); **G**. Basal laminal cells (*D.H.Vitt 27453*, ALTA); **H**, Capsule (*D.H.Vitt 27603*, ALTA). **I–Q**, *M. repandum*. **I**, Habit of dry branch (isolectotype of *M. pugionifolium*, NSW); **J**, Branch leaf (*D.H.Vitt 27167*, ALTA); **K**, Perichaetial leaf (*D.H.Vitt 28040*, ALTA); **L**, Dwarf male plant (*H.P.Ramsay 14d/75*, NSW); **M**, Capsule with operculum (isolectotype of *M. pugionifolium*, NSW); **N**, Calyptra (*D.H.Vitt 27301*, NSW); **O**, T.S. of upper laminal cells (*D.H.Vitt 27031*, ALTA); **P**, Upper laminal cells (*D.H.Vitt 27167*, ALTA); **Q**, Basal laminal cells (*D.H.Vitt 27031*, ALTA). **R–Y**, *M. funiforme*. **R**, Branch leaf (*D.H.Vitt 27890*, ALTA); **S**, Perichaetial leaf (*D.H.Vitt 27890*, ALTA); **T**, Dwarf male plant (*H.P.Ramsay 812112*, NSW); **U**, Capsule (*D.H.Vitt 27890*, ALTA); **V**, T.S. of upper laminal cells (*D.H.Vitt 27925*, ALTA); **W**, Upper laminal cells (*D.H.Vitt 27925*, ALTA); **X**, Basal laminal cells (*D.H.Vitt 27925*, ALTA); **Y**, Habit of dry branch (*H.P.Ramsay 812110*, NSW). Scale bars: 1 mm for habit and leaves; 100 µm for cellular drawings. Drawn by D.Mackay. B–H, J, K, M–Q, S and U–X redrawn from D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 325–451 (1985).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1.5–1.7 mm long, with a long decurved arista; costa excurrent, filling apex; upper laminal cells unistratose, ±flat, quadrate, 8–13 × 6–7 µm, smooth; mid-laminal cells ±rectangular-elliptical, 12–25 µm wide, smooth; basal laminal cells flat, narrow, rectangular, 20–50 µm long, evenly thick-walled, smooth. Perichaetial leaves erect, loosely subsheathing, lanceolate, 2.7–3.1 mm long; upper portion flexuose; cells elongate; costa long-excurrent. Calyptra indistinctly plicate, splitting by 1–several long slits, smooth, glabrous. Setae straight to flexuose, twisted to the left, thin, 12–16 mm long. Capsules long-exserted, oblong-elliptic to ovoid, 1.4–1.6 mm long, strongly 8-plicate below the small mouth, smooth. Peristome single; exostome teeth 16, well developed, erect, ±flexuose, finely papillose, pale; endostome absent. Spores isomorphic, 27–34 µm diam., coarsely papillose. Chromosome number not known. Fig. 25O–V.

Endemic to the Bellenden Ker Range, north-eastern Qld; grows on small twigs in elfin rainforest where it occurs with *M. microstomum*, *M. ligulaefolium*, *M. funiforme*, *M. leratii* and *M. involutifolium* subsp. *ptychomitrioides*. Map 89.

Qld: Mt Bellenden Ker, 2 Nov. 1981, *H.P.Ramsay* (NSW).

The species was first collected by F.L.E.Diels around 1900 (H-BR), and we have accepted the herbarium name used by Brotherus. It is closely related to *M. microstomum*, being similar in size and sporophyte characters, but differing in the branch and perichaetial leaves, the latter with a distinctive, long-excurrent costa in *M. dielsii*.

8. **Macromitrium exsertum** Broth., *Oefvers Förh. Finska Vetensk.-Soc.* 35: 35 (1893)

T: Clyde Mtn, N.S.W., *W.Baeuerlen 120b*; lecto: H-BR, *fide* D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 345 (1985); isolecto: MEL, NSW; Sugarloaf, *W.Baeuerlen 120a*; syn: H-BR; isosyn: MEL, NSW.

Illustrations: D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 346, figs 25–35; 348, figs 39–41 (1985).

Dioicous; males somewhat smaller than females. Plants large, lustrous olive-green above, dark brown to dull green below; branches to 3.2 cm tall. Branch leaves irregularly funiculate, spirally arranged, incurved-twisted to twisted-decurved when dry, straight and erect-spreading when moist, lanceolate, keeled, 2–3 mm long, with an acute to acuminate-cuspidate apex, plane on one side, reflexed-recurved in lower portion; costa curving to one side above, ending below or in the apex; upper laminal cells unistratose, smooth, flat, rarely slightly bulging, subquadrate-rounded, 5–7 µm long, thin-walled; mid-laminal cells flat, elongate-rhomboidal, 12–27 × 5–9 µm, ±thick-walled, smooth; basal laminal cells 35–50 × 6–8 µm, with a tall slender spiculose papilla; basal marginal border differentiated. Perichaetial leaves erect, straight, with a subsheathing lower portion, oblong to ligulate-lanceolate, 3.4–4.0 mm long; apex long and gradually acuminate; margin entire; costa slender, ending in the apex, the elongate lower cells continuing into apex. Calyptra lobed near base, slender-conical, glabrous. Setae flexuose, twisted to the left, thin, 8–11 mm long. Capsules ovoid, 1.5–2.0 mm long, smooth, narrowed to a darker 8-plicate puckered mouth; exothecial cells 21–46 × 10–24 µm, thin-walled. Peristome single; exostome teeth 16, well developed, inflexed-erect, narrow, ligulate-lanceolate, pale, coarsely papillose; endostome absent. Spores anisomorphic, 24–55 µm diam., ±smooth to finely papillose. Chromosome number not known. Fig. 23A–H.

Endemic to eastern Qld, eastern and south-eastern N.S.W. and A.C.T.; most frequent at higher elevations in montane rainforest, particularly those dominated by *Nothofagus moorei*. Map 90.

Qld: Nambani Rocks, SE of Binna Burra, Lamington Natl Park, *D.H.Norris 34361* (NSW). N.S.W.: Clyde Mtn, *W.W.Watts 5751* (NSW); Mt Budawang, Sept. 1982, *C.Helman 14* (NSW). A.C.T.: Capital Hill, *H.Streimann 38918* (CANB).

Macromitrium exsertum, one of the larger Australian species, is dioicous with larger, rather than dwarf, males plants. Although most laminal cells are smooth, each basal cell has a tall, spiculose papilla. While *M. stoneae* and *M. leratii* are similar in size and niche, the upper laminal cells of *M. leratii* are bulging and densely pluripapillose; these cells are only slightly bulging and densely pluripapillose with low branching papillae in *M. stoneae*. Moreover, the calyptrae of *M. stoneae* are hairy, but glabrous in *M. exsertum* and *M. stoneae*.

9. Macromitrium funiforme Dixon, *Proc. Roy. Soc. Queensland* 53: 30 (1941)

T: Mt Bartle Frere, Qld, 28 Oct. 1939, *H.Flecker 6411*; holo: BM; iso: CANB.

Illustrations: D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 354, figs 56–64; 356, figs 65–71 (1985).

Pseudautoicous. Plant robust, lustrous, red-brown to golden-green above, dark chestnut below; branches to 18 mm tall. Branch leaves distinctly funiculate, individually twisted-decurved to twisted-incurved with a flexuose apex, arranged in spirals when dry, spreading-incurved and funiculate when moist, ovate-lanceolate to lanceolate, 1.5–2.5 mm long; apex acuminate to acute; margin plane; costa forming an entire acumen, excurrent; upper laminal cells unistratose, subquadrate, rounded, 5–8 µm wide, smooth, flat, thick-walled; mid-laminal cells short- to long-rectangular, 6–9 µm wide, with straight to curved lumina, smooth, thick-walled; basal laminal cells rectangular, 19–48 × 7–8 µm, with straight lumina, smooth, sometimes with a few spiculose papillae, thick-walled. Perichaetial leaves erect, straight; lower portion subsheathing, lanceolate, 2.0–2.5 mm long, with a long acumen; costa filling apex. Calyptra plicate with 1–3 major slits and several smaller ones, glabrous. Setae long, flexuose, twisted to the left, thin, 8–10 mm long. Capsules ovoid to oblong-ellipsoidal, 1.6–2.0 mm long, 8-plicate, smooth; mouth puckered. Peristome single; exostome teeth 16, ±well developed; endostome absent. Spores anisomorphic, 12–16 µm and 16–26 µm diam., coarsely papillose. $n = 8$, *fide* H.P.Ramsay & D.H.Vitt, *J. Hattori Bot. Lab*. 61: 15–16 (1986). Fig. 23R–Y.

Endemic to the Cairns area of north-eastern Qld; grows on trunks and larger branches in elfin and montane rainforest. Map 91.

Qld: Mt Bellenden Ker, *D.H.Vitt 27890* (ALTA); Kennedy Falls, *W.B.Schofield 90734* (NSW); Mt Bellenden Ker, *H.P.Ramsay 812112* (NSW).

Macromitrium funiforme is often found in association with *M. stoneae*, *M. leratii* and *M exsertum*. It is distinguished from these species by its large size and chestnut colouration, branches more than 10 mm tall, branch leaves mostly more than 2 mm long, with a long-acuminate apex and an excurrent costa that fills the apex, and basal laminal cells that are smooth except for a few spiculose papillae.

10. Macromitrium hemitrichodes Schwägr., *Sp. Musc. Frond*., Suppl. 2, 2: 136 (1827)

T: locality unknown, Tas., *H.Sieber*, lecto: G, *fide* D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 395 (1985); isolecto: NY.

Macromitrium amoenum Hornsch. ex Müll.Hal., *Syn. Musc. Frond.* 1: 740 (1849). T: locality unknown, Tas., *H.Sieber*, lecto: BM, *fide* D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 395 (1985); isolecto: H-BR, NY.

Macromitrium intermedium Mitt., *Trans. & Proc. Roy. Soc. Victoria* 19: 63 (1882). T: Brisbane R., Qld, *F.M.Bailey*; holo: NY.

Macromitrium baileyi Mitt., *Trans. & Proc. Roy. Soc. Victoria* 19: 63 (1882). T: Brisbane R., Qld, *F.M.Bailey*; lecto: NY, *fide* D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 395 (1985).

Macromitrium sieberi Schwägr. ex Mitt., *Trans. & Proc. Roy. Soc. Victoria* 19: 63 (1882), *nom. nud.* (in synon.).

Illustrations: D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 396, figs 199–208; 398, figs 209–215 (1985).

Pseudautoicous. Plants medium-sized, dull, golden-green to olive-green above, dark green to rusty brown below; branches short, to 15 mm tall. Branch leaves loosely and irregularly twisted-contorted, upper portion decurved to strongly inrolled when dry, loosely erect-spreading when moist, lanceolate, 1.7–2.2 mm long, narrowed to a strong apiculus or stout mucro; margin plane to reflexed; costa slender but distinct, excurrent, forming the apiculus; upper laminal cells rounded, 7–10 µm wide, bulging, with 2–4 irregularly branched low papillae per cell; mid-laminal cells elliptical-rectangular, 12–20 µm long, pluripapillose, unipapillose below; basal cells elongate with straight lumina, 25–33 µm long, thick-walled, smooth, some cells with a single tall spiculose papilla, the basal border a single row of thin-walled rectangular cells. Perichaetial leaves erect, not extending much above vegetative leaves, lanceolate, 1.8–2.1 mm long, with an acute to acuminate apex; costa ending in the acumen, with pluripapillose upper cells, the lower cells elongate to mid-leaf. Calyptra slenderly conical, with numerous slits, sparsely hairy, the hairs straight and flexuose. Setae

slender, 4–10 mm long. Capsules ovoid, 1.4–2.0 mm long, 8-plicate below the small mouth. Peristome single; exostome teeth 16, lacking in old capsules, lanceolate, short, blunt, coarsely papillose; endostome absent. Spores anisomorphic, 12–31 µm diam., finely papillose. *n* = 9, *fide* H.P.Ramsay & D.H.Vitt, *J. Hattori Bot. Lab*. 61: 21–22 (1986). Fig. 22H–P.

Endemic to eastern Qld and N.S.W., Vic. and Tas. This is the most common *Macromitrium* from south-eastern Qld to south-eastern N.S.W.; grows on rock and bark. Map 92.

Qld: Ravenshoe, *W.W.Watts Q479* (NSW). N.S.W.: Bulladelah, *J.L.Boorman* (NSW); Stanwell Park, *W.W.Watts 8361* (NSW); Grays Is., Richmond R., *W.W.Watts 3061* (NSW); Zircon Ck, Mt Wilson, *H.P.Ramsay 11/80* (NSW).

Distinguished by the golden-green colour of the branches, long setae, lanceolate leaves and, especially, the densely papillose upper laminal cells with irregularly branched papillae giving the leaves an dull appearance. The leaves have a characteristic ‘crook’ when dry with the costa bending and the apex bent downwards and exposed to the side of the leaf.

11. Macromitrium hortoniae Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 367 (1985)

T: Lamington Natl Park, Qld, *D.H.Vitt 28150*; holo: ALTA; iso: CANB, H, NSW, NY; para: ALTA (*Vitt 28183, 27457, 27460, 27466*).

Illustrations: D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 368, figs 100–108; 370, figs 110–117 (1985).

Pseudautoicous. Plants small, olive-green to dark green above, darker below; branches short, to 6 mm tall. Branch leaves spreading-curved to flexuose-decurved, upper portion strongly inrolled when dry, flexuose-spreading with an inflexed apex when moist, ligulate to lanceolate-ligulate, strongly keeled, 1.6–2.5 mm long; apex obtuse to broadly acute; margin plane to reflexed and entire below, minutely crenulate above; costa ending just below apex, glossy, smooth; upper laminal cells strongly bulging, rounded, 7–10 µm wide, thin-walled, with 1–3 small ±conical papillae per cell to ±smooth; basal laminal cells near costa short, quadrate-rounded to short-rectangular, 9–15 × 8–11 µm, near margins smooth, almost flat, rectangular, 12–22 × 5–6 µm. Stem leaves flexuose-erect when dry, wide-spreading-flexuose when moist, lanceolate, c. 1 mm long; apex gradually acute; costa ending just below apex; laminal cells as in branch leaves. Perichaetial leaves erect, stiff, inconspicuous, much shorter than vegetative leaves, lanceolate, 1.2–1.5 mm long, with an acute apex; laminal cells as in vegetative leaves. Calyptra covering capsule and upper seta, deeply and uniformly lacerate into 10–15 slits, deeply plicate, smooth, glabrous. Setae flexuose-erect, 2–4 mm long. Capsules short-exserted, cylindrical to oblong, 1.0–1.4 mm long, not ribbed, firm, dark brown, smooth; mouth small. Peristome single; exostome teeth 16, erect to inflexed, blunt, lanceolate-ligulate, smooth to papillose; endostome absent. Spores indistinctly anisomorphic, 13–28 µm diam., finely papillose. *n* = 9, *fide* H.P.Ramsay & D.H.Vitt, *J. Hattori Bot. Lab*. 61: 17–18 (1986).
Fig. 24A–I.

Endemic to south-eastern Qld and north-eastern N.S.W.; recorded from tree trunks in ravine and montane rainforest. Map 93.

Qld: Binna Burra, *D.H.Norris 37524* (NSW); Lamington Natl Park, *D.H.Vitt 28183 sub. H.P.Ramsay 34/81* (NSW). N.S.W.: Myocum, *W.W.Watts 1526* (NSW); Belmore Falls, *W.W.Watts 9816* (NSW).

This, along with *M. caloblastoides*, is one of the smallest *Macromitrium* species in Australia, with branches to 6 mm tall and capsules 1.0–1.4 mm long. The leaves are the most slender in the *M. ligulare* group. Fertile material is readily distinguished by the glabrous calyptra that completely covers the capsule and has 10–15 slits nearly to the base of the rostrum, flaring outward and twisted to one side in its lower portion, the small, smooth capsules each with a small mouth and a firm, dark brown rim, the well-developed peristome with 16 erect teeth, and the anisomorphic spores.

12. Macromitrium incurvifolium (Hook. & Grev.) Schwägr., *Sp. Musc. Frond.*, Suppl. 2, 2: 144 (1827)

Orthotrichum incurvifolium Hook. & Grev., *Edinburgh J. Sci.* 1: 117 (1824). T: "Is. of Ternate, [Halmaheira, Indonesia] and in King Georges Sound, received from *Mr Dickson*"; lecto: E, *fide* D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab.* 59: 415 (1985); Ternate; syn: BM.

Illustrations: D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab.* 59: 414, figs 268–269, 271–273; 417, figs 275–284 (1985); D.H.Vitt, T.Koponen & D.H.Norris, *Acta Bot. Fenn.* 154: 37, fig. 16 (1995).

Pseudautoicous. Plants moderately large, lustrous, rusty brown to dark olive-green above, darker below. Stems inconspicuous, with branches to 15 mm tall. Branch leaves irregularly twisted-contorted, the apex hidden when dry, spreading and upper portion erect when moist, slender, lanceolate, keeled, 1.8–2.2 mm long; apex acute to short-acuminate; margin plane, entire; costa ending in apex or short-excurrent; upper laminal cells ±flat, rounded-quadrate to subquadrate, 5–8 µm wide, densely pluripapillose; mid-laminal cells also in longitudinal rows, somewhat bulging, quadrate to short-rectangular, 7–15 × 7–9 µm, thick-walled, smooth; basal laminal cells flat, elongate-rectangular, 13–33 µm wide, smooth, with irregular curved lumina, at margin the cells narrower and straight. Perichaetial leaves erect, sheathing, shorter than branch leaves, ligulate, 1.3–1.5 mm long, narrowed to a stout cusp; upper laminal cells elongate with curved lumina, shorter than basal cells. Calyptra conical, split by numerous slits to half-way, strongly plicate, glossy, smooth, with dense thick straight hairs. Setae straight, slender, 5–8 mm long, smooth. Capsules exserted, ovoid, 1.3–1.5 mm long, smooth to slightly 8-plicate; rim firm, not plicate. Peristome single; exostome teeth 16, ligulate-lanceolate, broken when old; endostome absent. Spores anisomorphic, 16–27 µm diam., finely papillose. $n = 9$ (Papua New Guinea), *fide* H.P.Ramsay, H.Streimann & D.H.Vitt, *Trop. Bryol.* 11: 154 (1995).

In Australia this moss is known only from north-eastern Qld; also in Papua New Guinea, Indonesia and Tahiti. Map 94.

Qld: Russell R., *W.A.Sayer* (NSW); Big Tableland, 26 km S of Cooktown, *H.Streimann 46281* (CANB); Mt Lewis State Forest, *H.Streimann 46083* (CANB).

Macromitrium incurvifolium is closely related to *M. leratii* and to the New Zealand species *M. gracile* (Hook.) Schwägr. Its smaller stature, the short and inconspicuous perichaetial leaves and densely hairy calyptra separate it from *M. leratii*; the upper cells of the branch leaves being in longitudinal rows distinguish it from all other species except *M. leratii.*

13. Macromitrium involutifolium (Hook. & Grev.) Schwägr., *Sp. Musc. Frond.*, Suppl. 2, 2: 144 (1827)

Orthotrichum involutifolium Hook. & Grev., *Edinburgh J. Sci.* 1: 117 (1824). T: Paramata [Parramatta], N.S.W., *Hobson s.n.*; lecto: E, *fide* D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab.* 59: 372 (1985); isolecto: BM, NY; King Georges Sound, New Zealand, *Dickson s.n.*; syn: BM, E.

Macromitrium daemelii Müll.Hal., *Hedwigia* 37: 153 (1898). T: Gayndah, Wideboy [Wide Bay], Qld, 1874, *[E.]Daemel*; lecto: H-BR, *fide* D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab.* 59: 372 (1985).

Macromitrium incurvulum Müll.Hal., *Hedwigia* 37: 155 (1898). T: locality unknown, Qld, 1893, *Rev. B.Scortechini s.n.*, in Herb. Saharampur, *Dr E.Levier*; lecto: H-BR, *fide* D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab.* 59: 372 (1985); isolecto: H-BR.

Macromitrium malacoblastum Müll.Hal., *Hedwigia* 37: 150 (1898). T: Walcha, N.S.W., 1884, *A.R.Crawford s.n.* in Herb. Melbourne; Cambewarra, N.S.W., Oct. 1884, *[J.A.]Thorpe* in Herb. Melbourne; Tilba [Tilba Tilba], N.S.W., 1880, *F.M.Reader s.n.* Herb. Melbourne; syn: H-BR; isosyn: NSW (*Thorpe 127*, Cambewarra) [no types located in MEL.].

Pseudautoicous. Plants medium to robust, dull, dark green to olive-green. Stems prostrate to ascending, with ascending to erect branches. Branch leaves loosely erect, upper portion strongly inrolled, not funiculate when dry, erect-incurved when moist, narrowly lanceolate to ligulate, 2.0–2.8 mm long; apex gradually and slenderly acute; margin plane or slightly reflexed, entire; costa slender, strong, usually ending just below apex; upper laminal cells unistratose, strongly bulging, rounded, 12–14 µm wide, smooth or rarely with 3 or 4 low papillae; mid-laminal cells similar to upper cells, 12–20 × 12–15 µm; basal laminal cells confined to a small area, rectangular-hexagonal, smooth or sometimes with a conical papilla.

Perichaetial leaves mostly inconspicuous, twisted-curved when dry, narrowly ovate to lanceolate, 1.9–2.1 mm long, with a gradually acuminate apex. Calyptra 2.5–3.0 mm long, divided by numerous slits, with dense straight hairs. Setae 1.5–5.0 mm long. Capsules short-exserted, cylindrical, 1.8–2.5 mm long, with a wrinkled neck and a non-plicate smooth darkened rim, rarely collapsed. Peristome single; exostome teeth 16, erect, lanceolate, short, very reduced or absent in some populations, striate with irregular papillae, pale. Spores anisomorphic, 17–31 µm diam., finely papillose.

This is the largest species in the *M. ligulare* group. The short setae, large cylindrical capsules with smooth non-plicate rims, densely hairy calyptrae as long as the capsules and the separation of older branches into distinct plants by breakdown of the stems characterise *M. involutifolium*. Sterile plants or those with immature capsules are difficult to determine to subspecies rank.

In Dorrigo National Park, N.S.W. the two subspecies grow mixed on branches and trunks of *Acacia*.

Peristome of 16 erect exostome teeth; capsule rim erect .... **13a.** subsp. **involutifolium**

Peristome very reduced or absent; capsule rim collapsed .... **13b.** subsp. **ptychomitrioides**

13a. Macromitrium involutifolium (Hook. & Grev.) Schwägr. subsp. involutifolium

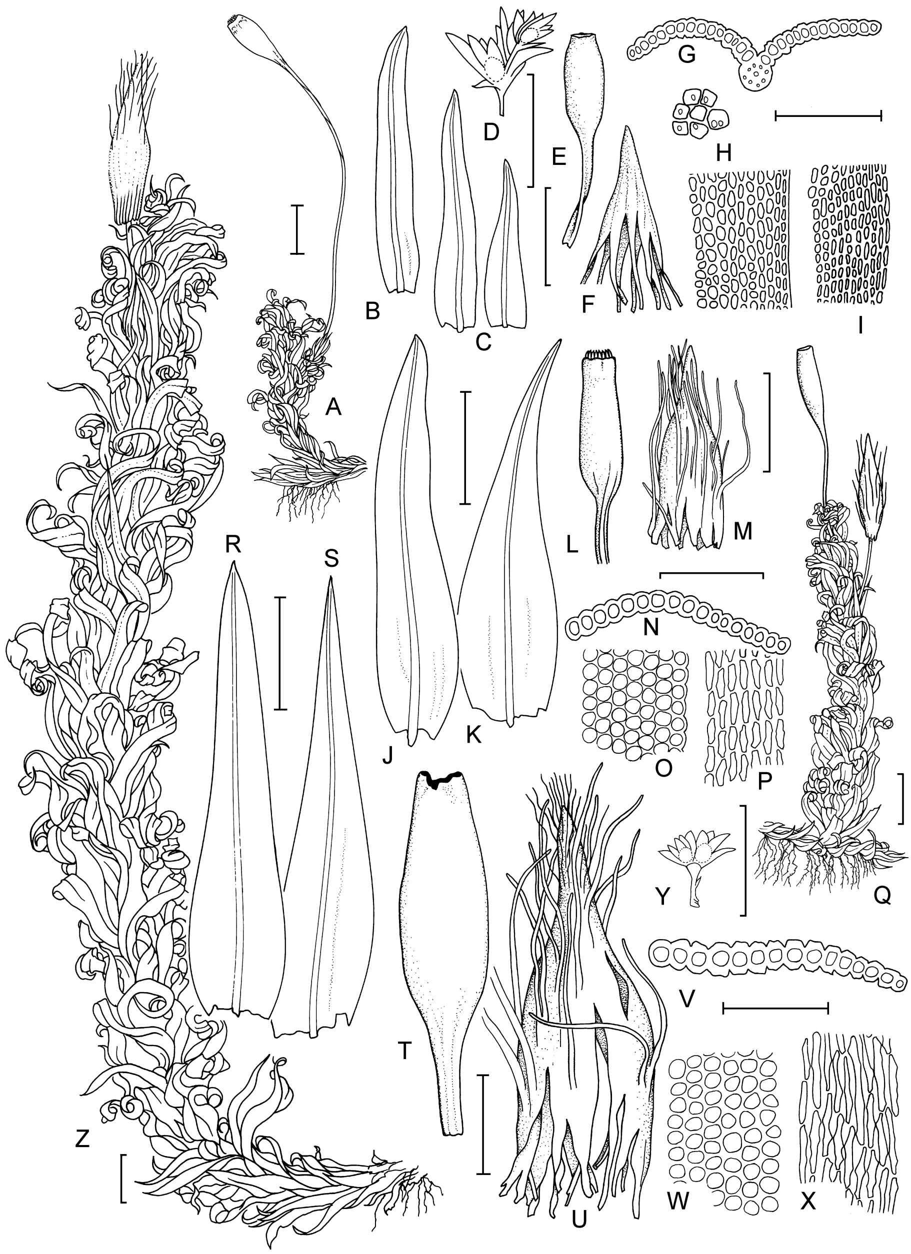
Illustrations: D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 374, figs 120–130; 376, figs 132–134, 136 (1985).

Plants medium-sized or, infrequently, robust; branches to 10 mm tall. Perichaetial leaves shorter than vegetative leaves. Capsules rim round, firm, erect, rarely collapsed; exothecial cells usually longer than broad, elongate-rectangular to nearly quadrate, 25–70 × 10–24 µm. Peristome of 16 erect exostome teeth, present even when old. *n* = 8, *fide* H.P.Ramsay & D.H.Vitt, *J. Hattori Bot. Lab*. 61: 18 (1986). Fig. 24J–Q.

Occurs from north-eastern Qld to south-eastern N.S.W.; most common from south of Brisbane to Sydney; also in New Caledonia. Grows on cliff faces, boulders and tree trunks; in the Sydney area and around Nowra it is common on sandstone outcrops and ranges from near the coast to mid-elevations in the Blue Mountains; it also occurs as an epiphyte in ravine rainforest and occasionally in montane rainforest. Map 95.

Qld: Bunya Mtns, *D.H.Norris s.n.* (NSW); Ravenshoe, *W.W.Watts Q490* (NSW). N.S.W.: Cambewarra, *J.A.Thorpe 4363* (NSW); Rodriguez Pass, Blackheath, *W.Forsyth s.n.* (NSW).

Figure 24. (opposite). *Macromitrium*. **A–I**, *M. hortoniae*. **A**, Habit of dry branch (*H.P.Ramsay G1973*, NSW); **B**, Branch leaf (*D.H.Vitt 28183*, ALTA); **C**, Perichaetial leaves (*D.H.Vitt 28183*, ALTA); **D**, Dwarf male plant (*H.P.Ramsay 852*, NSW); **E**, Capsule (*D.H.Vitt 28183*, ALTA); **F**, Calyptra (*D.H.Vitt 28183*, ALTA); **G**, T.S. of upper laminal cells (*D.H.Vitt 28150*, ALTA); **H**, Upper laminal cells with papillae (*D.H.Vitt 28150*, ALTA); **I**, Basal laminal cells (*D.H.Vitt 28150*, ALTA). **J–Q**, *M. involutifolium* subsp. *involutifolium*. **J**, Branch leaf (*D.H.Vitt 27152*, ALTA); **K**, Perichaetial leaf (*D.H.Vitt 27424*, ALTA); **L**, Capsule (*D.H.Vitt 27190*, ALTA); **M**, Calyptra (*D.H.Vitt 27152*, ALTA); **N**, T.S. of upper laminal cells (*D.H.Vitt 27152*, ALTA); **O**, Upper laminal cells (*D.H.Vitt 27299*, ALTA); **P**, Basal laminal cells (*D.H.Vitt 27424*, ALTA); **Q**, Dry branch (*W.W.Watts 9620*, NSW). **R–Z**, *M. involutifolium* subsp. *ptychomitrioides*. **R**, Branch leaf (*D.H.Vitt 28039*, ALTA); **S**, Perichaetial leaf (*D.H.Vitt 28075*, ALTA); **T**, Capsule (*D.H.Vitt 27297*, ALTA); **U**, Calyptra (*D.H.Vitt 27936*, ALTA); **V**, T.S. of upper laminal cells (*D.H.Vitt 27297*, ALTA); **W**, Upper laminal cells (*D.H.Vitt 287297* ALTA); **X**, Basal laminal cells (*D.H.Vitt 27297*, ALTA); **Y**, Dwarf male plant (*T.Whitelegge 1885*, NSW); **Z**, Habit of dry branch (*W.W.Watts 1916*, NSW). Scale bars: 1 mm for habit and leaves; 100 µm for cellular drawings. Drawn by D.Mackay; B, C, E–P, R–X redrawn from D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 325–451 (1985).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13b. Macromitrium involutifolium subsp. **ptychomitrioides** (Besch.) Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 378 (1985)

Macromitrium ptychomitrioides Besch., *Ann. Sci. Nat. Bot*., sér. 5, 18: 208 (1873). T: Canala, [New Caledonia], *Balansa 2540*; lecto: BM, *fide* D.H.Vitt & H.P.Ramsay, *loc. cit.*; isolecto: BM.

Macromitrium carinatum Mitt., *Trans. & Proc. Roy. Soc. Victoria* 19: 64 (1882). T: King Georges Sound, New Zealand, *Dickson*; holo: NY, *fide* D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 378 (1985).

Macromitrium viridissimum Mitt., *Trans. & Proc. Roy. Soc. Victoria* 19: 64 (1882). T: Burnett and Brisbane Rivers, Qld, *F.Mueller*; lecto: NY, *fide* D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 378 (1985); Toowoomba, Qld, [*C.H.*]*Hartmann*; syn: NY.

Macromitrium platyphyllaceum Müll.Hal., *Hedwigia* 37: 154 (1898). T: near Brisbane, Qld, 1898, *F.M.Bailey s.n.* in Herb. Brotherus; lecto: H-BR, *fide* D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 378 (1985).

Illustrations: D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 376, figs 131, 135, 137; 379, figs 139–149 (1985); H.Streimann, *The Mosses of Norfolk Island* 119, fig. 53 (2002).

Plants robust; branches to 25 mm tall. Perichaetial leaves narrowly lanceolate, gradually acuminate, mostly shorter than vegetative leaves. Capsules rim collapsed or very irregularly puckered, often with 3 or 4 indentations; exothecial cells quadrate or short-rectangular, 20–50 × 12–30 µm. Peristome usually completely absent, but some populations have a thickened basal rim. $n = 9$, *fide* H.P.Ramsay & D.H.Vitt, *J. Hattori Bot. Lab*. 61: 18 (1986). Fig. 24R–Z, Plate 21.

Occurs in eastern Australia from north-eastern Qld to south-eastern N.S.W.; also known from Norfolk Is., New Caledonia and the Tubai Is. in French Polynesia. Most frequently found as an epiphyte on tree branches and trunks, occasionally on rock. Map 96.

Qld: Eungella Natl Park, *D.H.Norris 38682* (NSW). N.S.W.: Bulgong Heights, *W.W.Watts* (NSW M12678); Tintenbar, *W.W.Watts 1942* (NSW); Hallidays Pt, *H.P.Ramsay 24/84* (NSW).

The absence of a peristome reliably separates subsp. *ptychomitrioides* from subsp. *involutifolium*, but there are some populations with a low, basal membrane which we have included in subsp. *ptychomitrioides*. The subspecific status is supported by the distribution, *ptychomitrioides* being found primarily at the north of the species range, and *involutifolium* southward, and also by the two subspecies maintaining their distinctiveness when growing together. Subspecific status is also supported by the chromosome number difference, but further counts are needed to confirm that this is true for a large number of populations. The lack of clear distinguishing features in the gametophore suggest that the differences are at the subspecific rather than the specific level.

14. Macromitrium leratii Broth. & Paris, *in* V.F.Brotherus, *Oefvers. Förh. Finska Vetensk.-Soc.* 48: 12 (1906)

T: Mount Dzumac and Mount Ouin, New Caledonia, *Le Rat*; lecto: H-BR ex PC, *fide* D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 421 (1985); Prony, [New Caledonia], *Etesse*; syn: H-BR, *fide* D.H.Vitt, T.Koponen & D.H.Norris, *Acta Bot. Fenn.* 154: 91 (1995).

Illustrations: D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 422, figs 288–297; 424, figs 298–304 (1985).

Pseudautoicous. Plants robust, lustrous, rusty brown to chestnut-brown, darker brown below, soft, with dull upper leaves; branches to 25 mm tall. Branch leaves loosely regularly and strongly twisted-flexuose, the apex decurved to incurved and exposed to one side when dry, indistinctly funiculate, wide-spreading and reflexed to erect-inflexed when moist, lanceolate from a broader basal area, 2–3 mm long; apex acute to short-acuminate; margin reflexed to plane, entire; costa ending in apex or short-excurrent, slender; upper laminal cells in distinct longitudinal rows, bulging, 6–7 (–9) µm wide, densely pluripapillose; mid-laminal cells similar, the transition to basal cells abrupt, the transitional cells flat, rectangular, 12–25 × 7–9 µm, with curved lumina, smooth; basal laminal cells flat, rectangular, 19–37 × 9–10 µm near costa, with strongly curved to sigmoidal lumina, smooth, narrowly elongate, 35–50 × 7 µm, thick-walled and with narrow lumina near margins. Perichaetial leaves erect, forming a stout plicate sheath around the vaginula and lower seta, as long as or longer than vegetative leaves, lanceolate, 2.8–3.5 mm long, gradually narrowed to an acuminate or stoutly cuspidate apex; costa excurrent or ending in a cusp; elongate cells sigmoidal, continuing into apex, all

cells flat, smooth. Calyptra broadly conical, split half-way by numerous slits, strongly plicate, glossy, mostly glabrous, smooth. Setae straight, slender, 5–7 mm long, smooth. Capsules exserted, ovoid, 1.4–1.6 mm long, slightly 8-plicate; rim firm, not plicate. Peristome single; exostome teeth 16, well developed, inflexed-erect, coarsely papillose on both surfaces, easily broken off and absent when old, pallid to bone-white; endostome absent. Spores anisomorphic, 10–21 µm diam., finely papillose. n = 8, *fide* H.P.Ramsay & D.H.Vitt, *J. Hattori Bot. Lab*. 61: 23 (1986).

Known from eastern Qld and north-eastern N.S.W.; also in Lord Howe Is. and New Caledonia. Locally abundant in montane rainforest where it is a dominant canopy species on *Nothofagus moorei*; also on *Doryphora sassafras* and *Ceratopetalum apetalum* and in elfin rainforest in north-eastern Qld. Map 97.

Qld: Hugh Nelson Ra., 15 km S of Atherton, *H.Streimann 29417* (CANB); Binna Burra, *D.H.Norris 37441* (NSW). N.S.W.: The Bulga, *W.W.Watts 10957* (NSW); Wilsons Ck, *W.W.Watts 1651* (NSW); Wiangaree State Forest, *H.P.Ramsay 19/81* (NSW).

One of the largest Australian species, *M. leratii* is distinguished by the rusty brown colouration, the large, bone-white exostome teeth, glabrous calyptrae, conspicuous perichaetial leaves, branch leaves with densely papillose upper laminal cells in longitudinal rows, and elongate, smooth, basal laminal cells with curved lumina.

15. Macromitrium ligulaefolium Broth., *Oefvers. Förh. Finska Vetensk.-Soc.* 40: 82 (1898), as *ligulifolium*

T: Roseville, Sydney, N.S.W., 1896, *W.W.Watts 178*; holo: H-BR; iso: NSW.

Macromitrium ligulatulum Müll.Hal., *Hedwigia* 37: 151 (1898). T: Richmond R., N.S.W., *Miss Hodgkinson* in Herb. Melbourne 1881; lecto: H-BR, *fide* D.H.Vitt, *J. Hattori Bot. Lab*. 54: 74 (1983) [holotype not located in MEL].

Macromitrium woollsianum Müll.Hal., *Hedwigia* 37: 156 (1898). T: locality unknown, N.S.W., *Harriott & Dr W.Woolls* in Herb. Melbourne 1881; lecto H-BR, *fide* D.H.Vitt, *J. Hattori Bot. Lab*. 54: 74 (1983) [holotype not located in MEL].

Illustrations: D.H.Vitt, *J. Hattori Bot. Lab*. 54: 63, fig. 176; 76, figs 208–218; 78, figs 221, 224, 225 (1983).

Pseudautoicous. Plants slender to medium-sized, green above, dark brown below; branches short, 5 (–10) mm tall. Branch leaves spreading-curved, with a strongly inrolled apex when dry, the apex usually exposed to one side of the leaf, flexuose-spreading and with an inflexed apex when moist, linear-lanceolate to ligulate, strongly keeled, 2–3 mm long; apex acute-apiculate, variable on any branch; margin plane to reflexed, entire below, minutely crenulate above; costa ending below or in apex, glossy, smooth; upper laminal cells in 6–15 rows between costa and margin, the cells rounded, uniform in size across leaf, 8–12 µm wide, strongly bulging with small papillae; mid-laminal cells similar to upper cells; transitional mid-leaf and basal cells rectangular, 12–20 × 10–12 µm, unevenly thickened, some with a prominent spiculose papilla. Perichaetial leaves shorter than vegetative leaves, stiffly erect, lanceolate, 1.3–1.6 mm long, with a slenderly acute apex. Calyptra conical-rostrate to conical, approaching cucullate, divided by 1–5 long slits or with 1 conspicuous slit, weakly plicate, smooth, with delicate fine hairs above or glabrous. Setae twisted to the left, thin, 5–6 mm long. Capsules long-exserted, narrowly ovoid to ellipsoidal, 1.4–1.5 mm long, smooth, darker below rim; rim 8-plicate below the narrow mouth. Peristome single, greatly reduced or absent; exostome a low papillose membrane 1–3 cells high, inconspicuous or absent; endostome absent. Spores anisomorphic, 15–25 µm diam., finely papillose. n = 9, rarely 8, *fide* H.P.Ramsay & D.H.Vitt, *J. Hattori Bot. Lab*. 61: 17 (1986).

Occurs in eastern Australia from northern Qld to Tas., abundant near Brisbane, common in N.S.W.; the most common *Macromitrium* in the Blue Mountains and from Sydney to Narooma, and in eastern and south-western Vic.; rare in New Zealand. The commonest species of ravine rainforests and on tree trunks and rocks around Sydney. Map 98.

Qld: Malanda, *W.W.Watts Q491* (NSW). N.S.W.: Roseville Gully, *W.W.Watts 178* (NSW); Megalong Valley, *H.P.Ramsay 34/83* (NSW). Vic.: Strzelecki State Forest, 17 km NE of Foster, *H.Streimann 51724* (CANB). Tas.: track to Westmoreland Falls, 7 km SSW of Mole Creek, *R.G.Coveny 17369a & P.D.Hind* (NSW).

Fertile specimens of *M. ligulaefolium* are usually easily separated from all other species of *Macromitrium* by means of leaf and cell characters, except the closely related species of the *M. ligulare* group. Related species can be separated as follows: *M. ligulare* has collapsed capsule rims and 16 well-developed teeth; *M. hortoniae* has striking calyptrae, deeply split into 10–15 slits; *M. caloblastoides* has capsule rims 8-plicate below a narrow, puckered mouth, broadly ligulate to oblong leaves and isomorphic spores; *M. involutifolium* is a much larger species with cylindrical capsules that are never 8-plicate or puckered at the mouth. Sterile specimens of *M. ligulaefolium* are often difficult to distinguish from *M. ligulare* and *M. caloblastoides*.

16. Macromitrium ligulare Mitt., *J. Proc. Linn. Soc., Bot.* 4: 78 (1860)

T: Waikeki, New Zealand, *Dr Sinclair*; lecto: NY, *fide* D.H.Vitt, *J. Hattori Bot. Lab*. 54: 74 (1983); syn: New Zealand, *Kerr*; NY.

Macromitrium leuhmannianum Müll.Hal., *Hedwigia* 37: 153 (1898). T: Gippsland, Vic., *V.Leuhmann* 1881 in Herb. Melbourne [holotype not located in MEL]; iso: H-BR.

Illustrations: D.H.Vitt, *J. Hattori Bot. Lab*. 54: 70, figs 190–200; 72, figs 201–206 (1983).

Pseudautoicous. Plants slender, yellow to olive-green above, darker below; branches short to medium, to 17 mm tall. Branch leaves flexuose-twisted, strongly inrolled, the apex hidden when dry, flexuose-spreading with an inflexed apex when moist, ligulate to lanceolate-ligulate, strongly keeled, 1.5–2.5 mm long; apex broadly acute or a short 1-celled apiculus; margin plane to reflexed and entire below, crenulate above; costa ending a few cells below the apex, glossy, smooth; upper laminal cells strongly bulging, rounded, 9–15 µm wide, thin-walled with ±thickened corners and 1–4 small strongly conical papillae; marginal cells elliptical to rounded, 7–12 µm long, 10–12 µm wide, similar in size to those near costa; mid-laminal transitional cells rounded-elliptical, 10–13 × 10–12 µm wide; basal laminal cells bulging to flat, short- to elongate-rectangular, 14–28 µm long, unevenly thickened, smooth, a few with a tall spiculose papilla. Perichaetial leaves erect, shorter than vegetative leaves, ovate-lanceolate, with a gradually acuminate or acute apex; upper laminal cells bulging, elliptical-rounded, papillose. Calyptra mitrate-cucullate, conical, ±entire or lobed at the base only, divided by 1–3 longitudinal slits, ±plicate, smooth, glabrous. Setae flexuose-erect, twisted to the left, thin, 4–8 mm long. Capsules long-exserted, narrowly oblong-ovate to cylindrical-oblong, 1–2 mm long, the mouth not contracted or ribbed, often partly collapsed when old, with a long wrinkled neck; urn smooth; exothecial cells of rim elongate, 26–50 × 5–10 µm. Peristome single; exostome teeth 16, erect-inflexed, blunt, transversely striate, papillose, pale; endostome absent. Spores indistinctly anisomorphic, 14–34 µm diam., finely papillose. $n = 8$, rarely 9, *fide* H.P.Ramsay & D.H.Vitt, *J. Hattori Bot. Lab*. 61: 17 (1986).

Occurs in Qld with one disjunct locality near Mackay, and from the Bunya Mountains and Brisbane south to N.S.W. and Vic. Common on tree trunks and larger branches in the Blue Mountains near Sydney. It is most abundant in ravine rainforest, especially on *Ceratopetalum apetalum*; it has not been collected on rock. Widespread in New Zealand. Map 99.

Qld: Bunya Mtns, *D.H.Norris 35308* (NSW). N.S.W.: Shoalhaven R., *W.Forsyth 328* (NSW); Blackheath, *W.W.Watts 10223* (NSW); Mt Wilson, *H.P.Ramsay 32/83* (NSW).

Macromitrium ligulaefolium replaces *M. ligulare* towards the northern end of its range, and from there into north-eastern Qld.

Distinguishing features are the tightly inrolled, short-apiculate leaves with the apex hidden in the inrolled part and the costa ending just below the apex, the strongly bulging upper laminal cells with 1–4 small, conical papillae, the perichaetial leaves that are usually shorter than the vegetative leaves, the glabrous calyptrae, the long setae and the capsules that have a completely smooth mouth that collapses irregularly when mature, a peristome of 16 teeth, anisomorphic spores, and exothecial cells of the capsule mouth that are much longer than broad. In difficult cases this last feature is diagnostic for the species. Sterile specimens of the closely related *M. ligulare*, *M. ligulaefolium* and *M. caloblastoides* are often difficult to distinguish from one-another.

17. Macromitrium longirostre (Hook.) Schwägr., *Sp. Musc. Frond.*, Suppl. 2, 1: 38, pl. 112 (1823)

Orthotrichum longirostre Hook., *Musci Exot*. 1: pl. 25 (1818). T: "Dusky Bay" [Dusky Sound], New Zealand, 1791, *A.Menzies*; holo: BM; iso: E, H-BR.

Orthotrichum acutifolium Hook. & Grev., *Edinburgh J. Sci*. 1: 118 (1824); *Macromitrium acutifolium* (Hook. & Grev.) Brid., *Bryol. Univ*. 1: 735 (1826). T: Van Diemens Land [Tas.], *Dr Spence & R.Neill*; lecto: E, *fide* D.H.Vitt, *J. Hattori Bot. Lab*. 54: 8 (1983); isolecto: BM.

Macromitrium pertorquescens Müll.Hal. var. *torquatulum* Müll.Hal., *Hedwigia* 37: 148 (1898); *M. torquatulum* (Müll.Hal.) Müll.Hal. & Broth., *Abh. Naturwiss. Vereine Bremen* 16: 501 (1900). T: Henty R., West Coast, Tas., Feb. 1891, *W.A.Weymouth*; holo: probably lost in Berlin; iso: H-BR, M.

Macromitrium rodwayi Dixon, *in* W.A.Weymouth & L.Rodway, *Pap. & Proc. Roy. Soc. Tasmania* 1921: 174 (1922). T: entrance to Port Arthur, Tas.; holo: BM; iso: NSW.

Illustrations: D.H.Vitt, *J. Hattori Bot. Lab*. 54: 9, figs 1–15; 11, figs 47–50 (1983); R.D.Seppelt, *The Moss Flora of Macquarie Island* 205, fig. 81 (2004).

Dioicous; with males and females robust and of similar size. Stems with branches to 30 mm tall, olive-green to yellow-green above. Branch leaves spirally twisted around the branch, with the apex curved outwards when dry, erect and straight to twisted when moist, narrowly lanceolate, keeled above, 2.3–4.0 mm long; apex acuminate to long-cuspidate; margin plane, entire; costa ending below apex or forming a narrow cusp; upper laminal cells rounded to elliptical, 5–12 × 4–10 µm, smaller at margins, slightly bulging to smooth, partly bistratose in upper one-third of leaf near costa; mid-laminal cells in ±longitudinal rows, quadrate to oblong, 10–15 × 8–10 µm, thick-walled, smooth or slightly bulging; basal laminal cells elongate-rectangular, 20–40 × 8–10 µm, thick-walled, smooth or rarely slightly bulging, near margin ±thick-walled, smooth, hyaline, 0–60 µm long. Perichaetial leaves similar to vegetative leaves. Calyptra deeply lacerate, strongly plicate, glabrous. Setae thick, twisted to the right, 3.5–8.0 mm long. Capsules exserted, fusiform-ovoid to cylindrical, 1.5–3.0 mm long, indistinctly broadly ribbed to smooth; exothecial cells elongate-sinuose to elliptical, 40–60 µm long, very thick-walled. Peristome double; exostome teeth 16, irregular, erect-curved when dry, incurved when moist, blunt to coarsely papillose, ±smooth below; endostome an irregular papillose membrane 1–3 cells high. Spores isomorphic, 25–30 µm diam., thick-walled, coarsely papillose. Chromosome number not known. Fig. 25A–G.

Most common in coastal Tas., also in King Is. in Bass Strait and Wilsons Promontory, Vic.; elsewhere on Subantarctic islands, New Zealand and southern South America. Grows on exposed coastal rock and on tree trunks and branches in coastal areas. Map 100.

Tas.: Safety Cove, Port Arthur, 18 May 1954, *J.H.Willis* (MEL); Woody Is., in narrows near Bramble Cove, Port Davey, *M.Davis 1379i* (MEL); L. Bellinger track, *W.A.Weymouth 570* (NSW); Macquarie Head near Queenstown, *J.R.Spence 4637* (NSW). Vic.: Wilsons Promontory, *coll. unknown* (MEL).

This species is characterised by: the robust habit; setae twisted to the right; plant size; narrowly lanceolate leaves that are spirally twisted around the branches and partly bistratose in their upper parts; leaf apices curved outwards when dry; laminal cells smooth and flat; the costa ending in a keeled, acuminate to cuspidate apex; the deeply lacerate, glabrous calyptra; and isomorphic spores.

18. Macromitrium microstomum (Hook. & Grev.) Schwägr., *Sp. Musc. Frond.*, Suppl. 2, 2: 130 (1827)

Orthotrichum microstomum Hook. & Grev., *Edinburgh J. Sci*. 1: 114 (1824). T: Van Diemens Land [Tas.], *Dr Spence*; lecto: E, *fide* D.H.Vitt, *J. Hattori Bot. Lab*. 54: 24 (1983) [1824, *Dr. Spence & W.R.Neill*]; isolecto: BM, MEL.

Macromitrium scottiae Müll.Hal., *Linnaea* 35: 618 (1868). T: Ash Is., N.S.W., *coll. unknown*; lecto: BM, *fide* D.H.Vitt, *J. Hattori Bot. Lab*. 54: 24 (1983).

Macromitrium linearifolium Müll.Hal., *Linnaea* 37: 154 (1872), *nom. illeg*. T: Mostland [probably Maitland], N.S.W., 1869, *Vickary*; lecto: BM, *fide* D.H.Vitt, *J. Hattori Bot. Lab*. 54: 24 (1983); isolecto: H-BR.

Macromitrium prolixum Bosw., *J. Bot*. 30: 97 (1892). T: Blue Mtns, N.S.W., *Roper*; holo: OXF.

Macromitrium tasmanicum Broth., *Oefvers Förh. Finska Vetensk.-Soc.* 37: 162 (1895). T: Circular Head, Tas., *W.A.Weymouth 846, 1040, 1041*; lecto: H-BR (*W.A.Weymouth 1040*), *fide* D.H.Vitt, *J. Hattori Bot. Lab.* 54: 24 (1983); syn: H-BR (*Weymouth 846, 1041*), "*nec non* Monte Wellington, f. *lutescens*. 121".

Macromitrium weymouthii Broth., *Oefvers Förh. Finska Vetensk.-Soc.* 37: 161 (1895). T: Porteus Gully, Macquarie Harbour, Tas., *W.A.Weymouth 574*; lecto: H-BR, *fide* D.H.Vitt, *J. Hattori Bot. Lab.* 54: 24 (1983); *loc. id.*, *W.A.Weymouth 573, 575* (part); syn: H-BR; Henty R., Tas., *W.A.Weymouth 569*; syn: H-BR.

Illustrations: G.A.M.Scott & I.G.Stone, *The Mosses of Southern Australia* 235, pl. 44 (1976), as *M. weymouthii*; D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab.* 54: 25, figs 52–61; 27, figs 63–68 (1983); D.H.Vitt, T.Koponen & D.H.Norris, *Acta Bot. Fenn.* 154: 49, fig. 21 (1995).

Autoicous. Plants slender, dull olive-green above. Stems with branches 4–6 mm tall. Branch leaves funiculate, in spirals, strongly twisted-contorted, ligulate to ligulate-lanceolate, strongly keeled, 1.2–2.0 mm long, with a single plica on one side; apex inrolled to incurved when dry, acute to short-acuminate, some short-cuspidate; margin entire; costa curving to one side, ending below apex or short-excurrent; upper laminal cells unistratose, to 9 µm wide, flat, smooth; mid-laminal cells 10–20 × 8–10 µm, flat, smooth; basal laminal cells narrow, rectangular, 24–55 µm long, smooth. Perichaetial leaves slender, erect, straight, long and slenderly acuminate or with a sharply cuspidate apex, 1.5–2.1 mm long; upper margin sparsely serrulate, contracted to the apex; costa slender; laminal cells similar to those of vegetative leaves. Calyptra deeply lacerate, mitrate, sometimes cucullate, plicate, glabrous. Setae long, flexuose, thin, twisted to the left. Capsules exserted, narrowly ovoid to oblong, 1.0–1.7 mm long, smooth, abruptly narrowed to the darker 8-plicate mouth. Peristome single; exostome teeth 16, erect to inflexed, narrow, lanceolate, c. 180 µm tall, papillose; endostome absent. Spores isomorphic, 30–54 µm diam., coarsely papillose. $n = 11$ ($10 + m$), *fide* H.P.Ramsay & D.H.Vitt, *J. Hattori Bot. Lab.* 61: 13 (1986). Fig. 25H–N.

Common in N.S.W., A.C.T., Vic. and Tas., less frequent in Qld; rather widespread in New Zealand, the Pacific islands north to Hawai'i, and in Java, New Guinea, Borneo and the Philippines and east to Central America. In Australia found mostly on small branches especially in the forest canopy. Map 101.

Qld: Hugh Nelson Ra., *H.Streimann 29489* (CANB). N.S.W.: Neates Glen, *W.W.Watts 6076* (NSW); Richmond R., *W.W.Watts 1377* (NSW). A.C.T.: Captains Flat, *H.Streimann 2517* (CANB). Tas.: Mt Montgomery, *D.H.Norris 33926* (NSW).

This is one of the most common and widespread species in Australia, and it is especially abundant on the canopy branches of temperate rainforest trees such as *Eucryphia moorei* and *Nothofagus moorei*. It is most likely to be confused with *M. dielsii* which is endemic to north-eastern Qld. However, *M. dielsii* has gradually narrowing leaves that end in a long, slender acumen completely filled by the excurrent costa, while *M. microstomum* has leaves ending in a narrowly acute to broadly acuminate tip, usually with the costa ending in or just below the apex. The perichaetial leaves also differ, having a long-excurrent costa in *M. dielsii*, while the apex is acuminate or cuspidate in *M. microstomum*.

The smooth upper and basal laminal cells distinguish this species from *M. ligulaefolium*, *M. hortoniae* and *M. ligulare*, all of which have bulging, papillose upper laminal cells. It is one of only four autoicous species in Australia (with *M. longirostre*, *M. dielsii* and *M. caloblastoides*).

19. Macromitrium repandum Müll.Hal., *Bot. Jahrb. Syst.* 5: 87 (1883)

T: locality unknown, Qld, *Naumann s.n.*; lecto: BM, *fide* D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab.* 59: 349 (1985); isolecto: E, H-BR.

Macromitrium whiteleggei Broth. & Geh., *Oefvers Förh. Finska Vetensk.-Soc.* 37: 161 (1895). T: Hurstville, near Sydney, N.S.W., *T.Whitelegge 301*; lecto: H-BR, *fide* D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab.* 59: 349 (1985); isolecto: H-BR, MEL, NSW; Bellenden Ker Range and Mt Bartle Frere, Qld, *S.Johnson s.n.*; syn: H-BR; isosyn: NSW.

Macromitrium pugionifolium Müll.Hal., *Hedwigia* 37: 145 (1898). T: Gosford, N.S.W., 1891, *T.Whitelegge*; lecto: H-BR, *fide* D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab.* 59: 349 (1985); isolecto: NSW; Richmond R., N.S.W., 1880, *Miss Hodgkinson*. "in Hb Melbourne"; syn: not located.

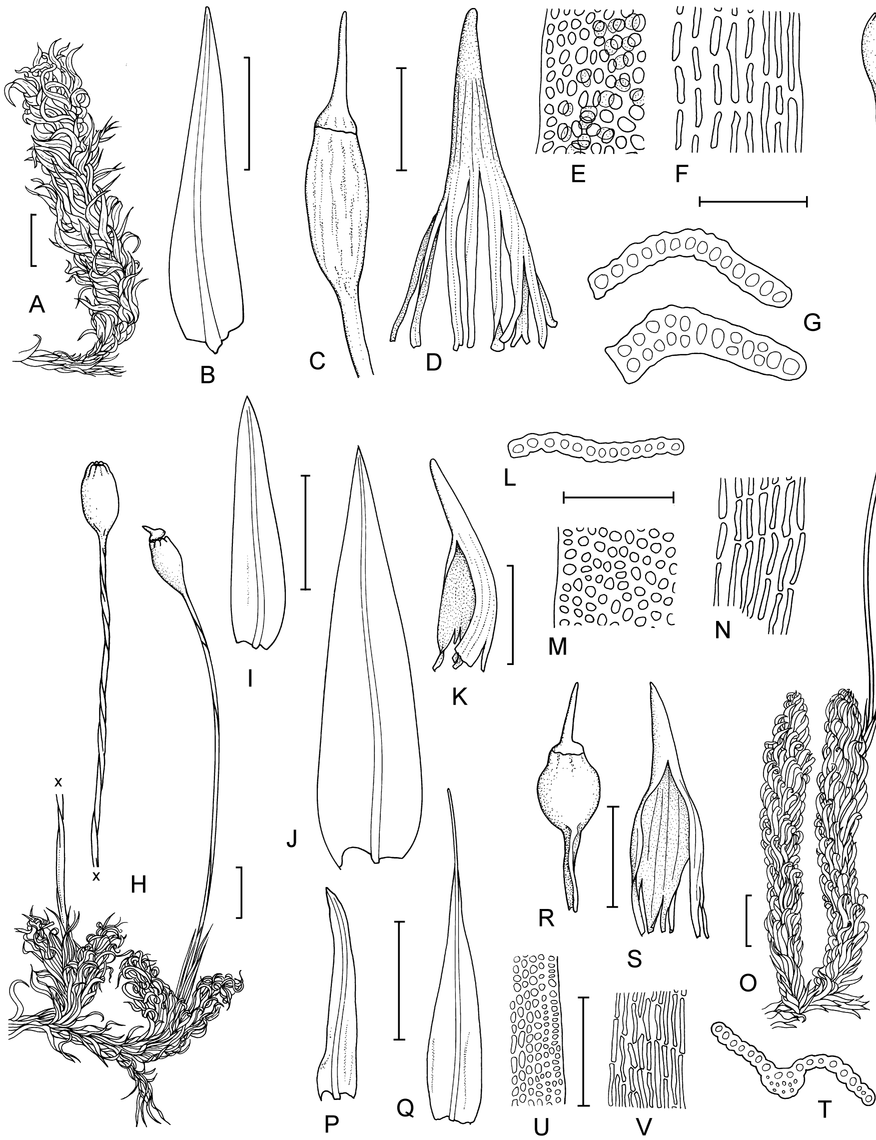

Figure 25. *Macromitrium*. **A–G**, *M. longirostre*. **A**, Habit of dry branch (*W.A.Weymouth 570*, CANB); **B**, Branch leaf (*D.H.Vitt 9384*, ALTA); **C**, Capsule with operculum (*D.H.Vitt 9275*, ALTA); **D**, Calyptra (*D.H.Vitt 9275*, ALTA); **E**, Upper laminal cells; bistratose cells shaded (*D.H.Vitt 8855*, ALTA); **F**, Basal laminal cells (*D.H.Vitt 8855*, ALTA); **G**, Upper leaf sections (*Bell 348*, H). **H–N**, *M. microstomum*. **H**, Habit of dry branch (*H.P.Ramsay 79166*, NSW); **I**, Branch leaf (*D.H.Vitt 1973*, ALTA); **J**, Perichaetial leaf (*D.H.Vitt 10325*, ALTA); **K**, Calyptra (*T.N.Beckett 146*, CHR); **L**, Upper leaf section (*Bell*, 1888, H); **M**, Upper laminal cells (*D.H.Vitt 10432*, ALTA); **N**, Basal laminal cells (*D.H.Vitt 10325*, ALTA). **O–V**, *M. dielsii*. **O**, Habit of dry branch (*H.P.Ramsay*, 1981, NSW); **P**, Branch leaf (*D.H.Vitt 27917*, ALTA); **Q**, Perichaetial leaf (*D.H.Vitt 27917*, ALTA); **R**, Capsule with operculum (*D.H.Vitt 27934*, ALTA); **S**, Calyptra (*D.H.Vitt 27934*, ALTA); **T**, Upper leaf section (*D.H.Vitt 27903*, ALTA); **U**, Upper laminal cells (*D.H.Vitt 27917*, ALTA); **V**, Basal laminal cells (*D.H.Vitt 27917*, ALTA). Scale bars: 1 mm for habit and leaves; 100 µm for cellular drawings. Drawn by D.Mackay; B–G, I–N, P–V redrawn from D.H.Vitt, *J. Hattori Bot. Lab*. 54: 1–94 (1983) and D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 325–451 (1985).

Macromitrium pallidovirens Müll.Hal., *Hedwigia* 37: 144 (1898). T: locality unknown, Qld, 1885, *F.M.Bailey & Kiaer*; lecto: MEL, *fide* D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 349 (1985); isolecto: H-BR, MEL.

Illustrations: D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 348, figs 36–38; 350, figs 43–54 (1985).

Pseudautoicous. Plants small, slender, olive-green to pale green above, dark below. Stems with dense short erect branches 5–8 mm tall, shorter near margins of mat. Branch leaves flexuose-curved to erect-curved and curved around the branch when dry, spreading and straight when moist, lingulate-lanceolate to oblong, 1.0–1.5 mm long, gradually narrowed to a long-cuspidate apex; margin entire; costa excurrent; upper laminal cells flat, rounded, 5–7 µm wide, smooth; mid-laminal cells flat, narrow, short-rectangular, 5–7 × 2–3 µm, smooth; basal laminal cells elongate, 20–50 µm long, straight, with the lumina flexuose to curved, mostly smooth, some scattered cells with a spiculose papilla, the basal marginal border differentiated. Perichaetial leaves erect, subsheathing, lanceolate-ovate, 1.5–2.0 mm long, sharply contracted to an acuminate-cuspidate apex; costa ending in the acumen. Calyptra usually evenly lobed, with one slit longer, plicate, usually glabrous. Setae flexuose, twisted to the left, thin, 4–12 mm long. Capsules emergent, narrowly ovoid to oblong, 1.0–1.6 mm long, smooth, with an 8-plicate mouth. Peristome single; exostome teeth 16, well developed, bluntly lanceolate, finely and evenly papillose, white; endostome absent. Spores distinctly anisomorphic, 23–43 µm diam., thick-walled, finely papillose. $n = 9$, *fide* H.P.Ramsay & D.H.Vitt, *J. Hattori Bot. Lab*. 61: 15 (1986). Fig. 23I–Q.

Endemic to eastern Australia (Qld and N.S.W.), mostly at low to moderate elevations, although one syntype of *M. whiteleggei* was collected at 1525 m on Mt Bartle Frere in north-eastern Qld. Grows on tree trunks and rocks in mesophytic habitats; in N.S.W. occurs in gully forest or wet ravines. Map 102.

Qld: Malanda, *W.W.Watts Q495* (NSW); Bribie Is., *H.P.Ramsay 14/75* (NSW). N.S.W.: E of Ballina, *W.W.Watts 5081* (NSW); Gosford, *T.Whitelegge 459* (NSW); Hurstville, *T.Whitelegge 30* (NSW).

Sporophytes are uncommon, and this species is distinguished by its small, pale green plants, erect-curved branch leaves, smooth, flat, upper laminal cells, basal laminal cells with a few, tall, spiculose papillae, elongate setae with 8-plicate, ovoid capsules, long-acuminate, differentiated, perichaetial leaves, glabrous calyptrae, anisomorphic spores and leaves ending in a retuse apex with the excurrent costa forming a stout cusp. This last feature distinguishes *M. repandum* from all other species. Species with which it appears superficially similar are *M. brevicaule* and *M. aurescens*, but these have papillose upper laminal cells.

20. **Macromitrium stoneae** Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 400 (1985)

T: Wauchope, N.S.W., Nov. 1981, *D.H.Vitt 27483*; holo: ALTA; iso: BRI, C, CANB, FH, H, NSW, NY.

Illustrations: D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 402, figs 218–229; 404, figs 230–236 (1985).

Pseudautoicous. Plants robust, dull, rusty brown to chestnut-green, darker brown below, in loose spreading mats; branches erect, broad, to 17 mm tall. Stem leaves loosely flexuose when dry, upcurved and erect-spreading when moist, lanceolate from a lanceolate-ovate base, 1.6–2.0 mm long; upper laminal cells slightly bulging, rounded, each with a single low papilla; mid-laminal cells elliptical-rounded; basal laminal cells elongate, smooth or sometimes with a single low papilla. Branch leaves obscurely funiculate when dry, strongly flexuose-twisted, keeled, lanceolate, 2.0–2.5 mm long; apex acuminate-apiculate, strongly twisted to one side when dry, wide-spreading and straight when moist; margin plane to slightly reflexed, entire above, infrequently crenulate along basal border; costa strong, ending in the apex; upper laminal cells only slightly bulging, rounded, 8–10 µm wide, densely pluripapillose with low branched papillae; mid-laminal cells similar, in longitudinal rows, subelliptical to rounded, 10–13 µm wide, thicker-walled, strongly bulging with several low ±branched papillae per cell; cells rounded in upper two-thirds of mid-leaf, becoming elongate in lower third, 9–17 × 9–11 µm, with irregularly fusiform lumina and a central papilla; basal laminal cells flat, 24–41 × 5–7 µm, with mostly straight lumina, usually smooth, the basal margin differentiated, with thin-walled cells, 20–25 × 9–11 µm, some with laterally projecting central papillae. Perichaetial leaves erect, stiff, distinctly sheathing, broadly lanceolate, 2.2–2.6 mm long, with a short and slender acuminate apex; costa ending in apex or short-

excurrent; upper laminal cells bulging, long-elliptical to rounded, smooth; basal cells elongate, smooth. Calyptra narrowly to broadly conical, plicate, evenly lacerate below, smooth, with abundant thin flexuose hairs. Setae erect, slender, 4–6 mm long. Capsules long-exserted, ovoid to oblong-ellipsoidal, 1.3–1.7 mm long, smooth below, narrowing in upper portion to a puckered 4–8-plicate mouth with a short narrow neck. Peristome single; exostome teeth 16, well developed, erect, ligulate to lanceolate, coarsely papillose on inner surface, finely papillose on outer surface; endostome absent. Spores anisomorphic, 15–35 µm diam., finely papillose. Chromosome number not known. Fig. 22Q–Z.

Known from the Cairns–Atherton area of north-eastern Qld, from Brisbane to Warwick (south-eastern Qld) and in Wauchope (N.S.W.). An uncommon epiphyte of trunks and larger branches in the canopy of montane rainforest; grows on *Nothofagus moorei* in N.S.W. Map 103.

Qld: Boonah, *D.H.Norris 37123* (NSW); Lamington Natl Park, *D.H.Norris 34670* (CANB); Binna Burra, *D.H.Norris 34471* (NSW). N.S.W.: Wauchope, *C.J.Quinn sub. H.P.Ramsay S277* (NSW).

The most distinctive feature of this species is the pattern of cell shape and anatomy in the branch leaves. The upper laminal cells are densely pluripapillose with low branched papillae, while the rounded cells of the upper two-thirds of the mid-leaf area give way to elongate cells with irregularly fusiform lumina in the lower third. The basal laminal cells are elongate with straight lumina and are usually smooth. The basal leaf margin has broader, thinner-walled cells, often with laterally projecting, central papillae. The superficially similar *M. hemitrichodes*, *M. incurvifolium* and *M. exsertum* are readily separable from *M. stoneae* by their leaf cell structure.

21. Macromitrium subulatum Mitt., *Trans. & Proc. Roy. Soc. Victoria* 19: 64 (1882)

T: “Bass Straits” [Strait, most likely Flinders Is.], Tas., *W.Milne*; holo: NY.

Illustrations: D.H.Vitt & H.P.Ramsay, *J. Hattori Bot. Lab*. 59: 412, figs 258–266; 414, figs 267, 270 (1985).

Probably pseudautoicous (dwarf males not seen). Plants very robust, lustrous, golden-brown above, dark rusty brown below. Stems loosely creeping, with ascending to erect branches to 20 mm tall. Branch leaves irregularly funiculate, spirally contorted to contorted-flexuose when dry, flexuose-twisted, wide-spreading and with an inflexed incurved apex from an erect base when moist, gradually narrowed to a long slender subula from a broad lower portion, strongly keeled throughout, 4–5 mm long; margin plane to slightly reflexed below; costa narrow, excurrent from the subula; upper laminal cells bulging, rounded, 9–11 µm wide, thick-walled, densely papillose with 4–6 conical papillae per cell; mid-laminal cells flat, rectangular, 14–25 × 9–11 µm, thick-walled, with straight to curved lumina, smooth, continuing distally along costa near margin and forming a border 2–5 cells wide; basal laminal cells flat, 35–60 × 8–10 µm near costa, very irregularly thick-walled, with variable lumina, smooth, becoming longer, straight and thinner near margin. Perichaetial leaves erect, subsheathing, long and conspicuous, lanceolate, 5.0–5.2 mm long, with a subulate-aristate apex; laminal cells elongate-rectangular, 9–11 µm wide, thick-walled, with straight lumina, smooth. Calyptra not seen. Setae straight, slender, 6–7 mm long, smooth. Capsules exserted, oblong, 1.3–1.8 mm long, not plicate at the mouth. Peristome single; exostome teeth 16, erect, lanceolate, densely papillose; endostome absent. Spores anisomorphic, 11–36 µm diam., finely papillose. Chromosome number not known.

This moss is represented only by the type specimen, collected on an island in Bass Strait, Tas. Map 104.

Macromitrium subulatum differs from all other Australian species in being robust, rusty brown and lustrous, with leaves that have a spirally contorted-flexuose, acuminate apex. The upper cells have 4–6 papillae per cell, and the basal cells are smooth.

While the type specimen may indeed have come from Flinders Is., it is possible that it was mislabelled and was not collected in Australia at all (D.Meagher, *Australas. Bryol. Newslett.* 48: 10, 2003).

Nomina nuda

Macromitrium baileyi Mitt., *Fragm*. 11 (Suppl.): 114 (1881)

Macromitrium caloblastum Müll.Hal. ex Kindb., *Enum. Bryin. Exot*. 92 (1888)

Macromitrium eucalyptorum var. *brevipedicillatum* Müll.Hal. ex Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 100 (1906)

Macromitrium eucalyptorum var. *gracile* Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 100 (1906)

Macromitrium hartmannii Müll.Hal. ex Kindb., *Enum. Bryin. Exot.* 66 (1888)

Macromitrium indistinctum Müll.Hal. ex Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 101 (1906)

Macromitrium macrophyllum Mitt. ex Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 102 (1906)

Macromitrium microblastum Broth. ex Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 102 (1906)

Macromitrium richmondiae Broth. ex Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 104 (1906)

Macromitrium ruficola Müll.Hal. ex Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 104 (1906)

Macromitrium rupicola Müll.Hal. ex Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 104 (1906)

Macromitrium sayeri Mitt. ex Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 104 (1906)

Macromitrium sheareri Broth. ex Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 105 (1906)

Macromitrium spirale Hampe, *Fragm*. 11 (Suppl.): 48 (1881)

Macromitrium subhemitrichodes Broth. ex Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 104 (1906)

4. ORTHOTRICHUM

Jette Lewinsky-Haapasaari† & Helen P. Ramsay[1]

Orthotrichum Hedw., *Sp. Musc. Frond.* 162 (1801); from the Greek *ortho* (erect) and *trichos* (a hair), in reference to the hairs present on the calyptra of some species.

Type: *O. anomalum* Hedw.

[1] c/- National Herbarium of New South Wales, Royal Botanic Gardens and Domain, Mrs Macquaries Road, Sydney, New South Wales 2000.

Autoicous (in Australia). Plants short to tall, erect, densely or loosely tufted. Stems usually branched. Leaves erect, appressed or, rarely, contorted when dry, markedly hygroscopic, ovate-lanceolate to lanceolate, usually unistratose and with an acute apex; costa strong, not reaching the apex; upper laminal cells rounded to short-rectangular, papillose, thick-walled; basal laminal cells rectangular or rhomboidal, smooth, sometimes with nodose and porose walls. Fusiform gemmae on leaves of some species. Perigonial and perichaetial leaves not or only slightly differentiated. Calyptra large, mitrate to conical, smooth or plicate, hairy or glabrous. Capsules on main stem, immersed, emergent or exserted, cylindrical to ovoid, usually ribbed when dry; exothecial bands usually 8, each 3 or 4 cells wide; stomata immersed or superficial, usually in the central capsule region; operculum conico-rostrate. Peristome single or double; exostome teeth 8 or 16, erect to strongly decurved when dry, papillose; endostome segments 8 or absent, derived from 1 or 2 cell rows, smooth or papillose. Spores unicellular, uniform, small or medium-sized, papillose.

A genus of c. 120 species predominantly in temperate regions in both hemispheres. Represented in Australia by five non-endemic species. Diversity is greater in New Zealand with nine species, four of which are endemic. *Orthotrichum* is mainly epiphytic on native and exotic hosts; it also occurs on calcareous and siliceous rocks. Only *O. tasmanicum* reaches as far north as Qld; other species occur in S.A., eastern N.S.W., A.C.T., Vic. and Tas. from sea level to 2000 m.

Four of the seven subgenera, *Orthotrichum* Hedw., *Phaneroporum* Delogne, *Cryptoporus* (Braithw.) Limpr. and *Pulchella* (Schimp.) Vitt, occur in Australia. These can be distinguished by their cytology, the position of the stomata and other characters. Subgenera with immersed stomata have the chromosome number $n = 6$, while those with superficial stomata have the chromosome number $n = 11$. This cytological correlation is consistent for the Australian taxa examined.

D.H.Vitt, The infrageneric evolution, phylogeny and taxonomy of the genus *Orthotrichum* (Musci) in North America, *Nova Hedwigia* 21: 683–711 (1972); I.G.Stone, Some new and noteworthy records of mosses mostly from Queensland, Australia, *Austrobaileya* 1: 511–520 (1982); J.Lewinsky, The genus *Orthotrichum* Hedw. (Musci) in Australasia. A taxonomic revision, *J. Hattori Bot. Lab.* 56: 369–460 (1984); H.P.Ramsay & J.Lewinsky, Chromosome studies on some Australasian Orthotrichaceae (Musci) I. *Orthotrichum*, *New Zealand J. Bot.* 22: 345–351 (1984); J.Lewinsky, *Orthotrichum* Hedw. in South America 1. Introduction and taxonomic revision of taxa with immersed stomata, *Lindbergia* 10: 65–94 (1984); D.H.Vitt & P.-L.Nimis, Typification of some Orthotrichaceous names published by G.Venturi, *Taxon* 36: 108–112 (1987); J.Lewinsky, *Orthotrichum* in South America 2. Taxonomic revision of taxa with superficial stomata, *Mem. New York Bot. Gard.* 45: 326–370 (1987); J.Lewinsky, A synopsis of the genus *Orthotrichum* Hedw. (Musci, Orthotrichaceae), *Bryobrothera* 2: 1–59 (1993).

1 Basal laminal cells usually with nodose, sometimes porose walls; stomata superficial 2

1: Basal laminal cells usually with smooth walls; stomata immersed 4

  2 Exostome erect to spreading when dry, roughly papillose; endostome often absent; leaves sometimes bistratose above; usually on rock *(1)* .... **4. O. rupestre**

  2: Exostome reflexed or recurved when dry, moderately papillose; endostome segments 8, well developed; leaves unistratose; usually epiphytic 3

3 Endostome segments usually 2 rows of cells, with compound papillae; setae long, distinct; capsules exserted *(2:)* .... **5. O. tasmanicum**

3: Endostome segments usually 1 row of cells, with papillae usually fusing into lines; setae short, indistinct; capsules emergent to short-exserted .... **3. O. hortense**

  4 Exostome teeth erect to spreading when dry; endostome usually absent or of small segments; capsules erect when dry; on calcareous rock *(1:)* .... **2. O. cupulatum**

  4: Exostome teeth recurved when dry; endostome well developed; capsules often recurved when dry; usually epiphytic .... **1. O. assimile**

1. Orthotrichum assimile Müll.Hal., *Syn. Musc. Frond.* 1: 704 (1849)

T: Chile, *E.F.Poppig s.n.*; lecto: H, *fide* J.Lewinsky, *Lindbergia* 10: 73 (1984).

Orthotrichum acroblepharis Müll.Hal., *Hedwigia* 37: 136 (1898). T: upper Ovens R., Vic., *A.McCann s.n.*; iso: JE.

[*Orthotrichum longithecum auct. non* R.Br.ter.: J.Lewinsky, *J. Hattori Bot. Lab.* 56: 436 (1984)]

[*Orthotrichum tasmanicum auct. non* Hook.f. & Wilson: H.P.Ramsay, *Austral. J. Bot.* 22: 308–309 (1974)]

[*Orthotrichum alpestre auct. non* Hornsch.: G.A.M.Scott & I.G.Stone, *The Mosses of Southern Australia* 228 (1976)]

Illustrations: J.Lewinsky, *J. Hattori Bot. Lab.* 56: 436, fig. 32; 438, fig. 33 (1984), as *O. longithecum*.

Plants loosely or densely tufted, 3.5–12.0 mm tall, yellow to olive-green above, brown to black below. Leaves appressed-flexuose when dry, ovate-lanceolate to lanceolate, 1.8–4.1 mm long; apex rounded-acute, acute or acuminate; margin recurved, entire, rarely dentate apically; upper laminal cells isodiametric, 6.5–20.0 µm wide, thick-walled, each with 2–4 low mostly unbranched papillae; basal laminal cells rectangular, 15–90 × c. 9.5 µm, usually thin-walled, smooth, without pores. Gemmae 5–7 cells long. Calyptra conical, plicate, split, with long hairs. Capsules immersed to emergent, sometimes recurved when dry, narrowly cylindrical, deeply 8-ribbed and constricted below mouth when dry; stomata immersed. Peristome double; exostome teeth 8, recurved, papillose; endostome segments 8, well developed, narrow. Spores 6–21 µm diam. $n = 11$ ($10 + m$), *fide* H.P.Ramsay, *Austral. J. Bot.* 22: 308–309 (1974), as *O. tasmanicum*; H.P.Ramsay, *J. Hattori Bot. Lab.* 74: 188 (1993). Fig. 27I–P, Plate 22.

Occurs in south-eastern N.S.W., A.C.T. and Vic.; also in New Zealand and South America. This species is primarily epiphytic, but it is also found on calcareous and non-calcareous rocks up to 1500 m. Map 105.

N.S.W.: Mt Canobolas, *H.Streimann 9184* (CANB); Yarrangobilly Caves, *H.P.Ramsay 5/66* (NSW); Island Bend, *H.Streimann 4020* (CANB). A.C.T.: Naas Ck, *H.Streimann 2293* (CANB). Vic.: Buchan Caves, *J.Lewinsky 1840* (C).

2. Orthotrichum cupulatum Hoffm. ex Brid., *Muscol. Recent.* 2(2): 25 (1801)

var. **cupulatum**

T: Göttingen, Germany, *G.F.Hoffmann*; holo: Herb. Bridel *n.v.*

Illustrations: J.Lewinsky, *J. Hattori Bot. Lab.* 56: 430, fig. 27; 434, fig. 30 (1984).

Plants loosely tufted, 12–20 mm tall, moderately glaucous, blue-green to olive-green above, brown to black below. Leaves slightly contorted when dry, lanceolate to ovate-lanceolate, 2.3–3.2 mm long; apex acute; margin recurved, entire; base decurrent; upper laminal cells isodiametric, 8–13 µm wide, each with 2 or 3 low unbranched papillae; basal laminal cells rectangular, 32–64 × 9.5–16.0 µm, thin-walled, without pores, smooth. Calyptra mitrate, split, plicate, papillose. Capsules immersed to emergent, ovoid-urceolate, ribbed and constricted below the mouth when dry; ribs alternating, 8 long and 8 short; stomata immersed. Peristome usually single; exostome teeth 16, erect to spreading; endostome usually absent. Spores 19.0–22.5 µm diam. $n = 11$, *fide* H.P.Ramsay, *J. Hattori Bot. Lab.* 74: 187–188 (1993). Fig. 27A–H, Plate 23.

This species occurs on calcareous rocks in south-eastern N.S.W., A.C.T. and eastern Vic.; also in New Zealand. It can tolerate large variations in temperature, but it is not found in very dry habitats. Map 106.

N.S.W.: Jenolan Caves, *H.P.Ramsay 8/87*, *15/87* (NSW); Glory Hole, Yarrangobilly Caves, *W.W.Watts s.n.* (NSW); Blue Water Holes, 42 km W of Adaminaby, *J.R.Spence 4472* (NSW). A.C.T.: Cotter Reserve, *H.Streimann 4765* (CANB). Vic.: Buchan R., *I.G.Stone 14207* (MEL).

A second variety, *O. cupulatum* var. *austrocupulatum* (Dixon & Sainsbury) Lewinsky, occurs in New Zealand.

3. **Orthotrichum hortense** Bosw., *J. Bot.* 30: 97 (1892)

T: Hanmer Plains, New Zealand, *W.Roper*; lecto: OXF, *fide* J.Lewinsky, *J. Hattori Bot. Lab.* 56: 418 (1984).

Illustration: J.Lewinsky, *op. cit.* 419, fig. 21 (1984).

Plants loosely tufted, 5–20 mm tall, bright green to olive-green above, dark brown below. Leaves slightly flexuose when dry, ovate-lanceolate, 2.4–3.4 mm long, unistratose; apex long-acuminate; margin recurved, entire; upper laminal cells isodiametric to short-rectangular, 8–19 × 6.5–14.5 µm, thick-walled, papillose; basal laminal cells rectangular to rhomboidal, 45–87 × 8–14 µm, thick-walled, not porose, each with 2 or 3 branched papillae. Calyptra conical, slightly split, plicate, hairy. Setae short. Capsules emergent or short-exserted, cylindrical, deeply 8-ribbed and constricted below the mouth when dry; stomata superficial. Peristome double; exostome teeth 8, recurved, moderately papillose; endostome segments 8, incurved, shorter than exostome, papillose. Spores 16–21 µm. Fig. 26O–V.

Rare in alpine, south-eastern N.S.W.; also in New Zealand and South America. Predominantly epiphytic, occasionally on rocks. Map 107.

N.S.W.: Yarrangobilly Village, *W.W.Watts 8503* (NSW); *loc. id.*, *I.G.Stone 10824* (MEL); Yarrangobilly Caves, *W.W.Watts 8901A* (NSW); near Lawn Cemetery, Khancoban, *R.G.Coveny 17525* (NSW); Cave Ck via Blue Waterholes fire-trail, Kosciuszko Natl Park, *R.G.Coveny 17530* (NSW).

There are no records of chromosome numbers for Australian collections, but the haploid number in New Zealand is n = 6 (H.P.Ramsay & J.Lewinsky, *New Zealand J. Bot.* 22: 346, 1984).

4. **Orthotrichum rupestre** Schleich. ex Schwägr., *Sp. Musc. Frond.*, Suppl. 1, 2: 374 (1816)

var. **rupestre**

T: Pasterze, Austria, *C.F.Schwägrichen*; lecto: G, *fide* J.Lewinsky, *J. Hattori Bot. Lab.* 56: 398 (1984).

Orthotrichum praeperistomatum Venturi, *Rev. Bryol.* 23: 67 (1896). T: “Mt Affred” [probably Mt Arthur], Tas., *Waymouth* [*W.A.Weymouth*]; holo: TR, iso: H.

Orthotrichum rupestriforme Venturi, *Rev. Bryol.* 23: 67 (1896). T: Queenstown, Tas., *Waymouth* [*W.A.Weymouth*] *5*; holo: TR.

Orthotrichum sullivanii Müll.Hal., *Hedwigia* 37: 137 (1898). T: Mt Kosciuszko, N.S.W., 1884, *D.Sullivan 8*; lecto: MEL; *fide* J.Lewinsky, *J. Hattori Bot. Lab.* 56: 398 (1984); isolecto: NSW; syn: Omeo, Vic., 1884, *J.Stirling* (MEL); Mt Ararat, Vic., 1883, *D.Sullivan s.n.* (MEL).

Illustration: J.Lewinsky, *op. cit.* 399, fig. 8 (1984).

Plants loosely to densely tufted or matted, 15–45 mm tall, olive-green to yellow-brown above, dark brown to black below. Leaves appressed and almost straight when dry, ovate-lanceolate, 3–4 mm long, partially bistratose above; apex acute; margin broadly recurved, entire; upper laminal cells isodiametric or elongate, 10.0–17.5 × 6.5–13.0 µm, with branched papillae; basal laminal cells rectangular or rhomboidal, 35–77 × 10–18 µm, with thick walls, nodose, with or without pores. Gemmae not known. Calyptra conical, slightly split, plicate, long-hairy. Capsules emergent, short-ovoid to short-cylindrical, sometimes shallowly 8-ribbed, with the mouth constricted when dry; stomata superficial. Peristome single or double; exostome teeth 8 or 16, erect to spreading, roughly papillose; endostome segments absent, or 8 in single row. Spores 20–26 µm diam. Chromosome number not known for Australia. Fig. 26A–F.

This cosmopolitan moss occurs in south-eastern N.S.W., A.C.T., north-eastern Vic. and Tas. Grows mainly on non-calcareous rocks and boulders, occasionally on trees and shrubs, in lowlands and on mountains in dry and moist areas. Map 108.

N.S.W.: Yarrangobilly Caves, *W.W.Watts 8941* (NSW). A.C.T.: Mt Gingera, *H.Streimann 3488* (CANB). Vic.: Falls Creek, *I.G.Stone 14231* (MEL).

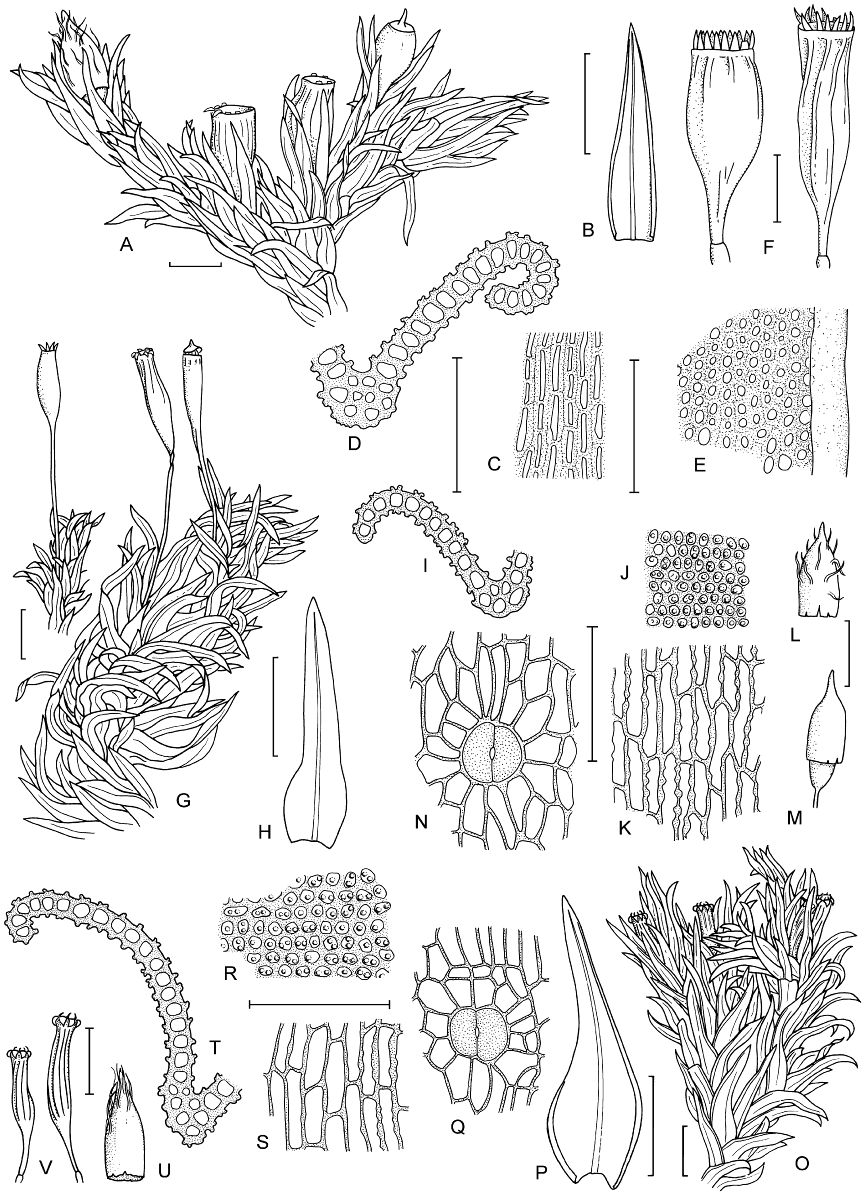

Figure 26. *Orthotrichum*. **A–F**, *O. rupestre*. **A**, Habit (*J.Lewinsky 1698*, CHR); **B**, Leaf; **C**, Basal laminal cells; **D**, T.S. of leaf; **E**, Upper leaf cells (B–E, *W.W.Watts 8827*, NSW); **F**, Capsules (*K.W.Allison 3899*, CHR). **G–N**, *O. tasmanicum*. **G**, Habit (right: *M.Martin 748*, H; left: *G.O.K.Sainsbury 4132*, C); **H**, Leaf (*K.W.Allison 3034*, S); **I**, T.S. leaf (*F.Mueller*, Hume R., MEL); **J**, Upper laminal cells (*K.W.Allison 3034*, S); **K**, Basal laminal cells (*G.O.K.Sainsbury*, Arthurs Pass, S); **L**, Calyptra (*G.O.K.Sainsbury 4132*, C); **M**, Capsule with calyptra (*M.Martin 748*, H); **N**, Superficial stoma (*F.Mueller*, Hume R., MEL). **O–V**, *O. hortense*. **O**, Habit (*J.Lewinsky 1674*, CHR): **P**, Stem leaf; **Q**, Superficial stoma; **R**, Upper laminal cells; **S**, Basal laminal cells; **T**, T.S. of leaf (P–T, lectotype); **U**, Calyptra (*J.Lewinsky 1674*, CHR); **V**, Capsules (*J.Lewinsky 1674*, CHR). Scale bars: 1 mm for habit and leaves; 100 µm for cellular drawings. Drawn by D.Mackay.

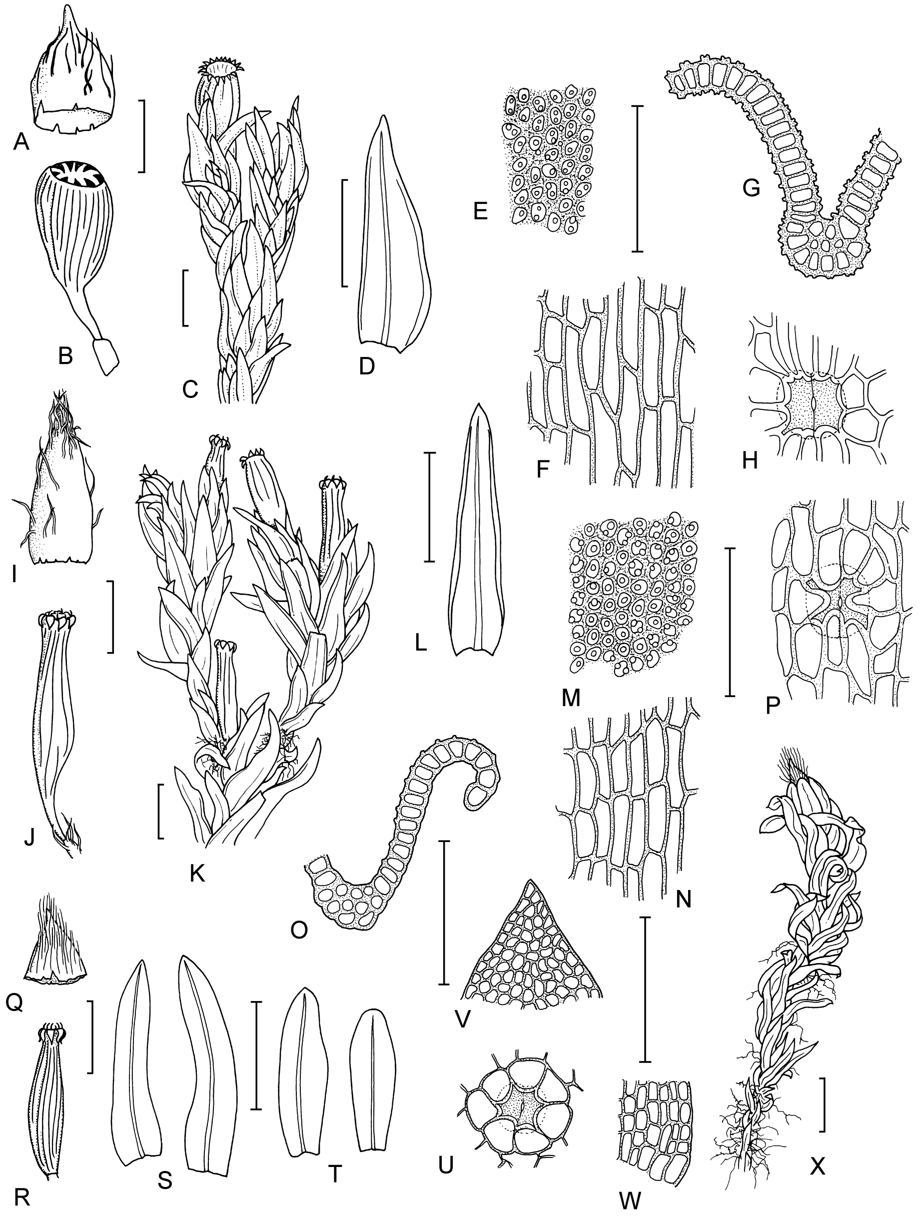

Figure 27. *Orthotrichum* and *Stoneobryum*. **A–H**, *O. cupulatum*. **A**, Calyptra; **B**, Capsule; **C**, Habit; **D**, Leaf; **E**, Upper laminal cells; **F**, Basal laminal cells; **G**, T.S. of leaf; **H**, Immersed stoma (A–H, *W.A.Weber & D.McVean B32430*, C). **I–P**, *O. assimile*. **I**, Calyptra (*J.Lewinsky 1154*, CHR); **J**, Dry capsule (*J.Lewinsky 1154*, CHR); **K**, Habit (*J.Lewinsky 1698*, CHR); **L**, Leaf (*W.W.Watts 8827*, NSW); **M**, Upper laminal cells (*W.N.Beckett*, Kaikoura, H); **N**, Basal laminal cells (*W.W.Watts 8827*, NSW); **O**, T.S. of leaf (*W.N.Beckett*, Kaikoura, H); **P**, Stoma (*Bell 298*, H). **Q–X**, *Stoneobryum bunyaense*. **Q**, Calyptra; **R**, Dry capsule; **S**, Stem leaves; **T**, Perichaetial leaves; **U**, Stoma; **V**, Apical laminal cells; **W**, Basal laminal cells; **X**, Habit (Q–X, holotype). Scale bars: 1 mm for habit and leaves; 100 µm for cellular drawings. Drawn by D.Mackay.

5. Orthotrichum tasmanicum Hook.f. & Wilson, *in* W.Wilson, *London J. Bot.* 7: 27 (1848) var. **tasmanicum**

T: North Esk R., Launceston, Tas., Sept. 1841, *R.C.Gunn 1629*; lecto: BM, *fide* J.Lewinsky, *J. Hattori Bot. Lab.* 56: 405 (1984); isolecto: MEL, NSW, WELT.

Orthotrichum lawrencei Mitt., *in* J.D.Hooker, *Bot. Antarct. Voy.* 3(2): 184 (1859). T: Tas., *R.W.Lawrence*; holo: BM.

Orthotrichum laterale Hampe, *Linnaea* 40: 309 (1876). T: Hume R., Vic., Jan. 1874, *F.Mueller*; iso: MEL, NSW.

Orthotrichum lateciliatum Venturi, *in* V.F.Brotherus, *Oefvers. Förh. Finska Vetensk.-Soc.* 35: 33 (1893). T: New Town Rivulet, Tas., *W.A.Weymouth 895*; lecto: TR, *fide* D.H.Vitt & P.-L.Nimis, *Taxon* 36: 109 (1987); isolecto: BM, H; St. Crispins, Mt Wellington, Tas., *W.A.Weymouth 897*; syn: TR.

Orthotrichum lateciliatum var. *apiculatum* Venturi, *in* W.A.Weymouth, *Pap. & Proc. Roy. Soc. Tasmania* 1894–95: 112 (1896). T: Hobart Rivulet, Tas., *W.A.Weymouth*; iso: H.

Orthotrichum encalyptaceum Müll.Hal., *Hedwigia* 37: 138 (1898). T: Mt Ararat, Vic., Sept. 1883, *D.Sullivan s.n.*; lecto: MEL, *fide* J.Lewinsky, *J. Hattori Bot. Lab.* 56: 406 (1984); isolecto: NSW; Mt Kosciuszko, N.S.W., 1884, *D.Sullivan s.n.*; syn: MEL.

Orthotrichum encalyptaceum Müll.Hal. var. *tenuisetum* Müll.Hal., *Hedwigia* 37: 138 (1898). T: southern Australia, *F.M.Campbell*; iso: BM.

Orthotrichum whiteleggei Müll.Hal., *Hedwigia* 37: 137 (1898). T: Moss Vale, N.S.W., *T.Whitelegge*; iso: MEL.

Orthotrichum campbelliae Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 94 (1906), *nom. nud.* Based on: “Victoria”, 1899, *O.Campbell* (MEL).

Orthotrichum waltheri Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 96 (1906), *nom. nud.*

Illustrations: G.A.M.Scott & I.G.Stone, *The Mosses of Southern Australia* 227, pl. 42 (1976); D.G.Catcheside, *Mosses of South Australia* 209, fig. 112 (1980); J.Lewinsky, *J. Hattori Bot. Lab.* 56: 406, fig. 13; 407, fig. 14 (1984).

Plants loosely tufted, 10–30 mm tall, olive-green, bright green or yellow above, dark brown below. Leaves crisped and contorted when dry, lanceolate to ovate-lanceolate, 2.7–3.7 mm long, unistratose; apex long-acute or acuminate; margin recurved, slightly undulate, entire; upper laminal cells isodiametric or short-rectangular, 6–13 µm long, thick-walled, papillose, the papillae sometimes branched; basal laminal cells rectangular to rhomboidal, 54.5–70.5 × 8.0–14.5 µm, thin- to thick-walled, nodose, porose. Gemmae not known. Calyptra mitrate, usually hairy. Setae long. Capsules long-exserted, cylindrical-ovoid, strongly ribbed in upper half or almost smooth when dry; stomata superficial. Peristome double; exostome teeth 8, recurved when dry, moderately papillose; endostome segments 8, in 2 rows, well developed, papillose. Spores 19–24 µm diam. $n = 6$, *fide* H.P.Ramsay, *J. Hattori Bot. Lab.* 74: 185 (1993). Fig. 26G–N, Plate 24.

Occurs in S.A., eastern Qld, southern N.S.W., A.C.T., Vic. and Tas., from sea level to 2000 m; also in New Zealand. Epiphytic on native and introduced shrubs and trees, rare on non-calcareous rocks; absent from dry areas. Map 109.

S.A.: Aldgate, *L.D.Williams 648* (MEL). Qld: Mt Elliott Natl Park, *I.G.Stone 18487* (MEL). N.S.W.: Macquarie Pass, *H.Streimann 4836* (CANB). A.C.T.: Naas Ck, *H.Streimann 2287* (CANB). Vic.: Sundial Peak, *I.G.Stone 7640* (MEL).

A second variety, var. *parvithecum* (R.Br.ter.) Sainsbury, occurs in New Zealand.

Two specimens listed as *nomina nuda* have been examined at MEL. *Orthotrichum waltheri*, named by Watts & Whitelegge as a synonym of the New Zealand species *O. calvum* Hook.f. & Wilson, has been identified as *O. tasmanicum* (A.W.Thies, *Australas. Bryol. Newslett.* 32: 4, 1995). *Orthotrichum campbelliae* has been studied by D.A.Meagher (pers. comm.) and was also found to be conspecific with *O. tasmanicum*. In his revision of *Ulota*, Malta (1933) found a specimen in C.Müller’s herbarium at H-BR labelled “Victoria, *O.Campbell*, 1889”, the same label data as the original specimen which he recorded as *O. tasmanicum* (Malta, 1933, p. 9).

5. SCHLOTHEIMIA

Dale H. Vitt[1] *& Helen P. Ramsay*[2]

Schlotheimia Brid., *Muscol. Recent.*, Suppl. 2: 16 (1812); named in honour of palaeobotanist Ernst Fredrick von Schlotheim (1764–1832).

Type: *S. torquata* (Hedw.) Brid.

Dioicous (pseudautoicous with dwarf males). Plants forming dense spreading mats, dull, olive-green to chestnut-green or brown to reddish green or reddish brown above and reddish below. Stems creeping, with erect branches covered by a rufous tomentum of thick-walled papillose rhizoids, simple or rarely branched by innovations beneath the perichaetia. Branch leaves erect-imbricate or spirally twisted when dry, ±rugose, erect-spreading to spreading-reflexed when moist; oblong to lanceolate-oblong, strongly keeled; margin reflexed below, entire; costa strong, excurrent or ending in or just below the apex; upper laminal cells uniform across lamina, short, elliptical to rounded-quadrate, smooth, the marginal cells oblate to quadrate, the juxtacostal cells in 2 or 3 rows; basal laminal cells elongate-rectangular to hexagonal-rhomboidal, straight, thick-walled, porose, smooth or papillose, hyaline to yellow. Gemmae not seen. Perichaetial leaves differentiated or not. Calyptra large, campanulate, with trapezoidal basal lobes covering the capsule at maturity, smooth, glabrous. Setae erect, long, twisted to the left, smooth. Capsules on erect secondary branches, long-exserted, ribbed or not, with numerous stomata in neck; annulus present in at least one species; operculum convex. Peristome double; exostome teeth 16, linear, revolute when dry; endostome segments 16–32, irregular, broad, blunt, 1/2–2/3 the length of the exostome. Spores isomorphic or anisomorphic.

A genus of c. 130 species, predominantly in the Southern Hemisphere (New Zealand, South America, Africa, Madagascar, Malesia and Australia). Two species are known from eastern and south-eastern Australia where they occur as epiphytes and on shaded rocks in wet forest; also close to the sea or brackish inlets. The genus differs from *Macromitrium* in the large, campanulate calyptra covering the capsule until maturity and the dense, red-brown tomentum of thick-walled, papillose rhizoids covering the stems.

D.H.Vitt, The genus *Schlotheimia* (Orthotrichaceae: Bryopsida) in Australia and New Zealand, *Bryologist* 92: 282–298 (1989); D.H.Vitt, T.Koponen & D.H.Norris, Bryophyte flora of the Huon Peninsula, Papua New Guinea. LIII. *Ulota* and *Schlotheimia* (Orthotrichaceae, Musci), *Acta Bot. Fenn.* 148: 5–25 (1993).

Branch leaves transversely strongly rugose above when dry; perichaetial leaves similar to vegetative leaves; capsules ribbed .... **1. S. brownii**

Branch leaves not rugose when dry; perichaetial leaves twice as long as vegetative leaves, sheathing the setae; capsules smooth .... **2. S. funiformis**

1. Schlotheimia brownii Schwägr., *Sp. Musc. Frond.*, Suppl. 2, 2: 52 (1826)

Macromitrium brownii (Schwägr.) Müll.Hal., *Bot. Zeitung (Berlin)* 3: 544 (1845). T: "In Nova Hollandia legit et dedit L.R.Brown" [Port Jackson, N.S.W., 1803]; holo: G.

Schlotheimia baileyi Broth., *Oefvers. Förh. Finska Vetensk.-Soc.* 33: 98 (1891). T: Bellenden Ker Range, Qld, 1889, *F.M.Bailey 612*; holo: H-BR; iso: BM, BRI.

Illustrations: D.H.Vitt, *Bryologist* 92: 291, figs 30–36; 292, figs 37–38, 42–43, 45 (1989).

Plants chestnut-green to dark reddish brown above; branches 6–8 mm tall; dwarf male plants 2–4 mm tall. Branch leaves imbricate-flexuose and tightly spirally twisted around the branch

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when dry, transversely rugose above, erect-spreading to spreading-reflexed when moist, narrowly oblong to lanceolate-oblong, strongly keeled in lower two-thirds, keeled above, 1.1–2.4 mm long; apex obtuse to retuse or mucronate; margin plane to reflexed below, entire; costa strong, ending in or just below the mucro; upper laminal cells uniform across lamina, in precise rows at angles of 60–90° to costa, flat, rounded-quadrate to subquadrate, 6–9 × 4–8 µm, smooth; juxtacostal cells in 2–4 oblique longitudinal rows; basal laminal cells 30–50 × 5–8 µm, smooth or with a small terminal papilla. Perichaetial leaves similar to vegetative leaves. Calyptra 4-lobed below. Setae 4.5–5.0 mm long. Capsules long-exserted, cylindrical, 8-ribbed along their entire length, widest at the mouth when old; exothecial cells short (2–4: 1), thick-walled, in bands of narrower and wider cells; annulus 1 or 2 rows of thin-walled cells. Peristome double; exostome teeth 16, linear, conical when moist, revolute when dry; endostome segments 16–32, 1/2–2/3 the length of the exostome teeth, broad, irregularly shaped. Spores isomorphic, (16–) 20–40 (–50) µm diam., coarsely papillose. n = 11, *fide* H.P.Ramsay, *in* G.C.S.Clarke & J.G.Duckett, *Bryophyte Systematics* 14: 303–304 (1979). Fig. 20J–R.

Occurs in eastern Qld and N.S.W.; also in Lord Howe Is. and New Caledonia. Mainly epiphytic on *Nothofagus* (rarely on *Eucalyptus*), and also on rocks; collected from sea level to 1400 m. Map 110.

Qld: summit of Mt Bellenden Ker, 1889, *F.M.Bailey* (BRI). N.S.W.: Ballina, *W.W.Watts 5709* (NSW); Apple Tree Bay, Bobbin Head, *H.P.Ramsay 2/77* (NSW).

Although the protologue of *Schlotheimia brownii* cited only “Nova Hollandia” as the type locality, the holotype in Schwägrichen’s herbarium (G) has the locality as “Port Jackson 1803” [Sydney, N.S.W.]. *Schlotheimia baileyi*, from the higher elevations of Mt Bellenden Ker (Qld) is synonymous, these northern populations having more loosely arranged leaves typical of more tropical, epiphytic plants. The New Zealand species *S. knightii* Müll.Hal. is closely related.

2. Schlotheimia funiformis Taylor ex Dixon, *Notes Roy. Bot. Gard. Edinburgh* 120: 94 (1948)

T: “Nov. Hollandia”, [Australia], “Herb. Edinb. (138)”; holo: E; iso: BM.

Illustrations: D.H.Vitt, *Bryologist* 92: 292, figs 37, 41, 44; 294, figs 47–51 (1989).

Plants olive-green above, chestnut-brown to reddish green below; branches to 10 mm tall. Branch leaves erect-imbricate, funiculate, not rugose, tightly spirally arranged above when dry, erect-spreading when moist, oblong to ligulate-oblong, strongly keeled to apex, 1.2–1.5 mm long; apex obtuse, mucronate; margin entire; costa ending in the mucro; upper laminal cells in 14 or 15 rows across lamina, flat, rounded-quadrate to subquadrate, 6–9 × 4–8 µm, smooth; juxtacostal cells elongate; basal laminal cells 25–50 × 6–7 µm. Perichaetial leaves conspicuous, loosely erect-sheathing, ovate-lanceolate, 2–3 mm long, with an acute mucronate apex. Calyptra to 8-lobed below, smooth. Setae 6–7 mm long. Capsules long-exserted, broadly cylindrical, 1.7–1.8 mm long, smooth; exothecial cells uniform, very short (3–4: 1), thick-walled, with a narrow mouth and rim cells in 5 or 6 differentiated rows. Peristome double; exostome teeth 16, linear, conical when moist, partially revolute when dry; endostome segments 16, 2/3–3/4 the length of the exostome teeth, narrow, irregularly shaped, with an acute apex. Spores distinctly anisomorphic, 12–34 µm diam., coarsely papillose. Chromosome number not known. Fig. 20S–Y.

This endemic species occurs in north-eastern Qld, in the border ranges between Qld and N.S.W and in northern coastal areas of N.S.W.; grows on bark and rock. Map 111.

Qld: confluence of Echo Ck and Davidson Ck, Cardwell Ra., SE of Ravenshoe, *H.Streimann 29105* (BRI, CANB, HO, NSW); Mt Baldy, near Atherton, *H.Streimann 29220* (CANB); Darling Downs, *R.D.Hoogland 11810* (CANB, NSW). N.S.W.: Weeping Rocks, New England, *H.Streimann 47697* (CANB).

Schlotheimia funiformis differs from *S. brownii* in having non-rugose leaves with obtuse, mucronate apices, smooth basal cells, conspicuous, erect perichaetial leaves twice the length of vegetative leaves, smooth rather than ribbed capsules, 8-lobed calyptrae and distinctly anisomorphic spores.

6. STONEOBRYUM

Helen P. Ramsay[1]

Stoneobryum D.H.Norris & H.Rob., *Bryologist* 84: 96 (1981); named in honour of Dr Ilma Stone (1913–2001), noted Australian bryologist.

Type: *S. bunyaense* D.H.Norris & H.Rob.

Dioicous. Male plants smaller, scattered through female clones, often in leaf axils, usually unbranched. Plants erect, tufted, in small hemispherical cushions, pale green to bleached whitish green. Stems sparingly branched near base. Rhizoids repeatedly branched with ±equal dichotomies, smooth, deep red. Leaves oblong to slightly lanceolate-lingulate, somewhat crisped above the sheathing base, with axillary hairs at costal insertion; apex abruptly contracted to broadly acute and spirally inrolled; margin recurved throughout limb, plane to recurved near apex, entire at base; a single fold on each side of the leaf; costa ending below apex, sunken in a channel; upper and median laminal cells isodiametric to oblong-elliptical, smooth to slightly mammillose; basal laminal cells rectangular, thin-walled, not differentiated at margin, hyaline. Perichaetial leaves closely enveloping capsules, rigidly ascending and strongly concave, lingulate, costate, not plicate, with plane margins and an obtuse apex; laminal cells large, rhomboidal, smooth, hyaline. Calyptra covering operculum and 25–33% of the urn, mitrate, slightly plicate, pilose, not lobed or laciniate, with smooth hairs. Capsules on main stem, cylindrical, completely immersed, on very short setae, abruptly contracted to a short neck, strongly 8-ribbed; stomata immersed, restricted to urn. Peristome double; exostome teeth in 8 pairs, recurved; endostome segments 8, upright, filiform; cilia solitary, smooth; operculum short-apiculate. Spores anisomorphic. Chromosome number not known.

A genus of two species, one Australian, the other from South Africa. The difference in size of the sexes might be related to the anisospory. The differentiated, colourless perichaetium that encloses the capsule almost replaces the reduced, hairy calyptra. These characters, together with immersed stomata, separate this genus from *Orthotrichum*.

D.H.Norris & H.Robinson, *Stoneobryum*, a new genus of Orthotrichaceae from South Africa and southern Queensland, *Bryologist* 84: 95–99 (1981).

Stoneobryum bunyaense D.H.Norris & H.Rob., *Bryologist* 84: 96 (1981)

T: Bunya Mountains Natl Park, Qld, 8 Mar. 1974, *D.H.Norris 35310*; holo: BRI; iso: HSC, US.

Illustrations: D.H.Norris & H.Robinson, *op. cit.* 97, figs 1–10 (1981).

Plants in small hemispherical cushions to 20 mm wide, 3–5 mm tall. Leaves 1.8–3.0 mm long, 0.3–0.4 mm wide; apex broadly acute; costa ending well below apex; sheathing leaf base slightly but abruptly wider than lamina; upper and median laminal cells isodiametric to oblong-elliptical, 8–11 µm wide, smooth to slightly mammillose; cells of sheathing base rectangular, 12–14 µm long (3–6: 1), thin-walled. Larger spores c 27 µm diam.; smaller spores c. 18 µm diam. Fig. 27Q–X.

Known only from the type locality in south-eastern Qld where it grows on the high branches of *Eucalyptus* sp. Map 112.

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7. ULOTA

Helen P. Ramsay[1]

Ulota D.Mohr, *Ann. Bot.* 2: 540 (1806); from the Greek *oulos* (woolly or curly), in reference to the curled leaves of some species.

Type: *U. crispa* (Hedw.) Brid.

Autoicous, rarely dioicous. Plants in loose short cushions or tufts. Stems ascending to erect, rarely creeping and with upright branches, simple, sparsely branched. Leaves usually flexuose, sometimes twisted-contorted, crisped or little-altered when dry, spreading when moist, linear to linear-lanceolate from an expanded ovate obovate or oblong base, concave, acuminate; apex acute or subacute; margin plane, ±revolute in the middle; costa strong, sunken in a deep channel, prominent abaxially, ending below apex or percurrent; upper laminal cells small, isodiametric to short-rectangular, thick-walled, papillose; basal laminal cells elongate, thick-walled, with a conspicuous border of quadrate to short-rectangular hyaline cells with thickened transverse walls. Gemmae rarely present. Perichaetial leaves ±differentiated. Calyptra mitrate, deeply lobed at base, pilose with long erect hairs. Setae long, twisted to the right. Capsules on main stem or branches, exserted, subcylindrical to oblong-ovoid, rarely urceolate, usually deeply 8-ribbed when dry, the base ±tapering to form a neck; stomata superficial, usually restricted to neck, rarely on rim; operculum conico-rostrate to rostellate; rim hyaline, sometimes yellow or red. Peristome double; prostome present in one species; exostome teeth 8 pairs, sometimes splitting, spreading or recurved when dry, minutely papillose, sometimes trabeculate or perforate; endostome segments 8 or 16, slender to filiform, rarely broad and irregular, shorter than teeth. Spores usually unicellular, isomorphic, globose.

A genus of about 50–60 species. These mosses are primarily epiphytes, common on the bark of trees mainly in temperate climates; rarely on rock. *Ulota* is represented in Australia by five species and two additional varieties; one species and two varieties are endemic. All are present in Tas., and three occur in Vic. mainly at high altitudes. None has been found in tropical, north-eastern Qld, although some species occur in Papua New Guinea (D.H.Vitt, *Acta Bot. Fenn*. 148: 5–25, 1995).

Some species of *Ulota* closely resemble *Orthotrichum* in growth form, peristome structure and capsule shape, while others resemble *Macromitrium* in growth form, cell structure of the vegetative leaves, habitat and leaf set. *Ulota* is distinguished by leaves that are often twisted or crisped when dry, the very thick-walled, papillose, upper laminal cells, the expanded leaf base with a well-differentiated border of a few to many rows of quadrate to rectangular hyaline cells, and the strongly 8-ribbed capsules. The distinctively bordered leaf base separates *Ulota* from other genera in the Orthotrichaceae.

The specimens on which Malta's (1933) revision was based were borrowed from Venturi's herbarium at Trento (TR) and Brotherus' herbarium at Helsinki (H-BR). The latter collections, borrowed by Malta in Riga in the 1920s, were thought to have been destroyed, but these were located and returned to H-BR in 1996. In addition, Australian collections of W.A.Weymouth at HO were examined, among which are a number of isotypes. Although not annotated as such nor apparently examined by Malta, these match both label data and actual specimens in BM and TR.

The identity of the species accepted here is confirmed by the fact that they can be readily separated in mixed populations. Species are difficult to name on leaf characters alone, but they can be recognised by a combination of leaf and sporophyte attributes. Capsules differ in shape, the presence or absence of a long neck, colour of the rim, location of stomata, and differences in the peristome, especially the endostome. Leaves on sterile shoots should be examined to avoid confusion with perichaetial leaves.

[1] c/- National Herbarium of New South Wales, Royal Botanic Gardens and Domain, Mrs Macquaries Road, Sydney, New South Wales 2000.

W.Mitten, Descriptions of some new species of Musci from New Zealand…, *J. Proc. Linn. Soc., Bot.* 4: 64–100 (1860); G.Venturi, *Ulota, in* V.F.Brotherus, *Oefvers. Finska Förh. Vetensk.-Soc.* 35: 42–44 (1893); W.A.Weymouth, Some additions to the moss flora of Tasmania, *Pap. & Proc. Roy. Soc. Tasmania* 1893: 200–210 (1894); L.Rodway, *Tasmanian Bryophyta* 113–116 (1914); H.N.Dixon, Studies in the bryology of New Zealand, with special reference to the herbarium of Robert Brown, *Bull. New Zealand Inst.* 3(4): 180 (1926); 3(6): 365–366 (1929); N.Malta, A survey of Australasian species of *Ulota*, *Acta Horti Bot. Univ. Latv.* 7: 1–24 (1933); G.O.K.Sainsbury, Notes on Tasmanian mosses from Rodway's Herbarium: III, *Pap. & Proc. Roy. Soc. Tasmania* 89: 13–20 (1955); G.O.K.Sainsbury, A handbook of New Zealand mosses, *Bull. Roy. Soc. New Zealand* 5: 1–490 (1955); D.H.Vitt, The genera of Orthotrichaceae, *Beih. Nova Hedwigia* 71: 261–268 (1982); D.H.Vitt, T.Koponen & D.H.Norris, Bryophyte flora of the Huon Peninsula, Papua New Guinea. LIII. *Ulota* and *Schlotheimia* (Orthotrichaceae, Musci), *Acta Bot. Fenn.* 148: 5–25 (1993); S.J.Jarman & B.A.Fuhrer, *Mosses and Liverworts of Rainforest in south-eastern Australia* 50 (1995).

1 Plants in tufts; leaves slightly twisted, not crisped when dry; capsules thick, almost pyriform; spores 70–90 µm diam., often multicellular .... **4. U. membranata**

1: Plants in cushions or tufts, or creeping; leaves twisted or crisped when dry; capsules subcylindrical to oblong-ovoid; spores 20–35 µm diam., unicellular 2

2 Plants usually with creeping stems and erect branches; leaves 1.0–1.8 mm long, scarcely to slightly twisted when dry, upper leaves with projecting apices *(1:)* .... **5. U. viridis**

2: Plants erect, without creeping stems; leaves at least 2 mm long, twisted or strongly crisped when dry; apices not projecting 3

3 Leaves strongly crisped when dry, usually indented by recurvature of the margins for a short distance immediately above the broad ovate base; capsules 8-ribbed from mouth to base of urn; neck long, tapering, smooth, often twisted with the seta when dry *(2:)* .... **3. U. lutea**

3: Leaves twisted, rarely crisped when dry, lacking the indentation above the ovate or oblong base; capsules ribbed to base; neck absent or very short 4

4 Leaves with broad ovate bases; basal marginal hyaline border usually 4–6 rows wide; rim of operculum yellow; stomata in middle to upper parts of urn; endostome segments filiform, nodose *(3:)* .... **1. U. cochleata**

4: Leaves with obovate-oblong bases; basal marginal hyaline border usually 6–12 rows wide; rim of operculum red; stomata in base of urn or neck; endostome segments broad, usually with a median zig-zag line .... **2. U. laticiliata**

1. Ulota cochleata Venturi ex Broth., *Oefvers Förh. Finska Vetensk.-Soc.* 35: 42 (1893)

T: Springs to Falls, Mt Wellington, Tas., 2. Mar. 1891, *W.A.Weymouth 898*; holo: TR; iso: HO.

Ulota membranacea D.H.Ashton & R.F.McCrea, *Victorian Naturalist* 87: 254 (1970), *nom. nud.*

Illustrations: N.Malta, *Acta Horti Bot. Univ. Latv.* 7: 2, fig. 1f (1933); S.J.Jarman & B.A.Fuhrer, *Mosses and Liverworts of Rainforest in Tasmania and South-eastern Australia* 51, fig. 32 (1995).

Autoicous. Plants in yellowish brown tufts. Stems erect. Leaves strongly twisted but not crisped when dry, widely spreading and twisted when moist, linear-lanceolate, c. 2 mm long, narrowly acuminate with an acute apex; base expanding to asymmetrical, broadly ovate; costa ending below or in apex; upper laminal cells short-rectangular; mid-laminal cells irregularly rounded and thicker-walled; basal laminal cells very narrow, long, the basal marginal cells in 4–6 rows. Perichaetial leaves sheathing at base. Setae 2.5–5.0 mm long, yellowish. Capsules oblong-ovoid to subcylindrical, 8-ribbed to base; operculum with a yellow rim; stomata in middle to upper part of urn. Peristome: exostome teeth lanceolate, densely papillose, perforate and trabeculate at apices, splitting, recurved when dry; endostome segments 8, filiform, nodose. Spores unicellular, 27–30 µm diam., finely papillose. Chromosome number not known. Fig. 28K–T.

A rare endemic in Vic. and Tas.; found at high altitudes in the canopy of, for example, *Nothofagus* and *Tasmannia*. Map 113.

Vic.: Healesville, *I.G.Stone 779* (MEL); Cumberland, *I.G.Stone 9230* (MEL). Tas.: L. Lea, 16 May 1992, *S.J.Jarman s.n.* (HO).

Index Muscorum listed *U. cochleata* as a synonym of *U. viridis* and attributed this synonymy to Malta (*op. cit.* 13), a decision followed by Streimann & Curnow (*Catalogue of the Mosses of Australia and its External Territories* 388, 1989) and Streimann & Klazenga (*Catalogue of Australian Mosses* 181, 2002). This is an error, probably based on H.N.Dixon (*Bull. New Zealand Inst.* 3(6): 366, 1929) who examined a specimen (*Weymouth 1524*, named as *U. cochleata*, but not the type and not authenticated by Malta), and suggested that it was similar to *U. anceps* (now in synonymy with *U. viridis*). Dixon was correct in determining that *Weymouth 1524* is *U. viridis* (*U. anceps*). However, *U. cochleata* is a distinct species (Malta, 1933; Scott & Stone, 1976).

Ulota cochleata is difficult to identify on leaf structure alone, although the twisted (but not crisped) leaves, even when moist, are longer above the base than those of other species. The location of the stomata in the middle to upper parts of the urn rather than the base and neck of the capsule, and the filiform, nodose endostome segments are also distinctive.

The oblong-ovoid capsules differ from those of *U. lutea* in the absence of the long neck and the filiform endostome segments. Although the leaves have ovate, concave bases similar to *U. lutea*, they lack indentations above the base, and they also differ in the width of the hyaline borders. Moreover, the upper cells are more rectangular and less thick-walled.

2. **Ulota laticiliata** Malta, *Acta Horti Bot. Univ. Latv.* 7: 11 (1933)

T: Recherche Bay, Tas., 17 Jan. 1911, *W.A.Weymouth 2487*; lecto: H-BR, *fide* H.P.Ramsay, *Fl. Australia* 51: 411 (2006); isolecto: HO; Mt Wellington, Tas., 6 Mar. 1891, *W.A.Weymouth 227*; syn: H-BR; isosyn: HO.

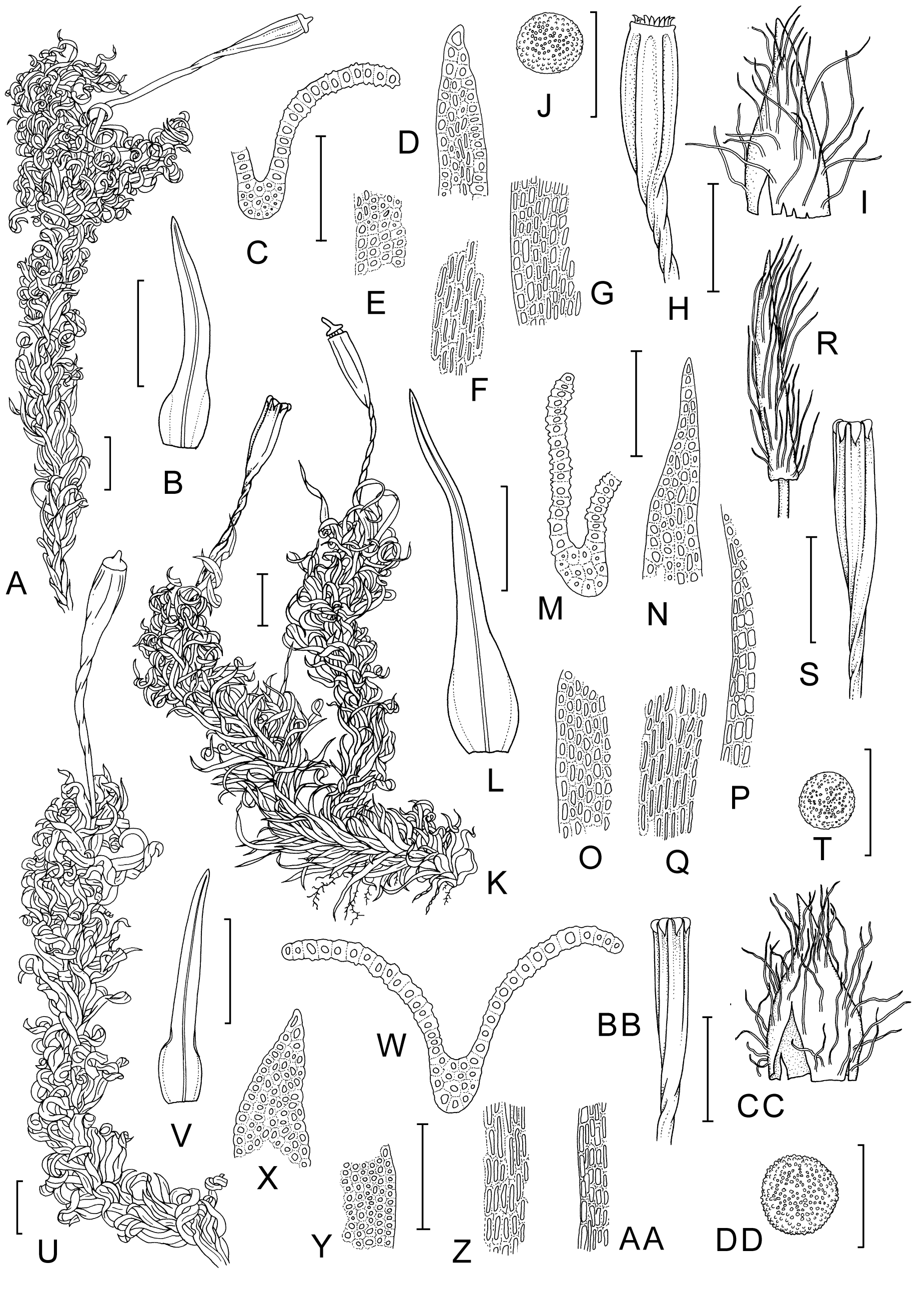
Illustrations: N.Malta, *Acta Horti Bot. Univ. Latv.* 7: 12, fig. 5 (1933); G.O.K.Sainsbury, *Bull. Roy. Soc. New Zealand* 5: 221, pl. 35, fig. 3 (1955).

Autoicous. Plants 10–15 mm tall, in yellowish tufts, brown below. Stems erect. Leaves curled, twisted, not strongly crisped when dry, erecto-patent when moist, linear-lanceolate, 1.5–2.0 mm long, gradually widening to an obovate to oblong concave base; apex acuminate; costa ending below apex; upper laminal cells irregularly isodiametric, 8–10 µm wide; basal laminal cells very narrow; marginal cells quadrate, in 6–10 (–12) rows. Perichaetial leaves longer than vegetative leaves. Setae 3.5–8.0 mm long. Capsules oblong-ovoid, short, 1.0–1.6 mm long, becoming subcylindrical when dry, not or slightly constricted below the mouth, 8-ribbed to base, urceolate when old; urn yellow, reddish at mouth; stomata on base of urn or neck. Peristome spreading, upright, not recurved when dry, slightly striate above; endostome segments 8, broad, usually with a zig-zag median line, slightly striate. Spores unicellular, 24–34 µm diam., papillose. Chromosome number not known. Fig. 28A–J.

Tas.: Netherby Ck, Central Highlands, *A.Moscal 13694* (CANB, HO); Pencil Pine Lodge, 24 Dec. 1986, *A.V.Ratkowsky s.n.* (HO); Liffey R., *A.Moscal 17740* (HO).

Uncommon in Tas., although recent collections have extended its range; also in New Zealand. Epiphytic on trees (e.g. *Nothofagus*) or shrubs (e.g. *Leptospermum*) above 800 m. Map 114.

Figure 28 (opposite). *Ulota*. **A–J**, *U. laticiliata*. **A**, Habit, with capsules and operculum (*A.Moscal 18497*, HO); **B**, Leaf; **C**, T.S. of leaf; **D**, Apical leaf cells; **E**, Mid-leaf cells; **F**, Marginal hyaline basal cells; **G**, Mid-basal laminal cells; **H**, Capsule with peristome; **I**, Calyptra; **J**, Spore (B–J, isotype, HO). **K–T**, *U. cochleata*. **K**, Habit, with capsules, operculum and peristome; **L**, Leaf; **M**, T.S. of leaf; **N**, Apical laminal cells; **O**, Mid-leaf cells; **P**, Marginal hyaline basal cells; **Q**, Mid-basal laminal cells; **R**, Calyptra; **S**, Capsule, **T**, Spore (K–T, *J.Jarman s.n.*, HO). **U–DD**, *U. lutea* var. *lutea*. **U**, Habit, with capsule and operculum (*H.P.Ramsay* 5/88 NSW); **V**, Leaf; **W**, T.S. of leaf; **X**, Apical leaf cells; **Y**, Mid-leaf cells; **Z**, Marginal hyaline basal cells; **AA**, Mid-basal laminal cells; **BB**, Capsule with recurved peristome teeth (V–BB, isotype of *U. weymouthii*, HO); **CC**, Calyptra; **DD**, Spore (CC, DD, *D.Ratkowsky H499*, HO). Scale bars: 1 mm for habit, calyptra, capsules and leaves; 100 µm for cellular drawings; 50 µm for spores. Drawn by D.Mackay and H.P.Ramsay.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Distinguished in the field by leaves that are curled and twisted but not strongly crisped when dry, the short, ovoid to oblong, ribbed capsules with red rims, the peristome teeth spreading and upright but not recurved when dry, and the broad endostome segments usually with a median zig-zag line. It differs from *U. lutea* by having leaves that are gradually, rather than abruptly, narrowed from the base, and a broader hyaline border.

In New Zealand, this species has been synonymised with *U. lutea* (A.J.Fife, *Bryologist* 98: 301–357, 1995).

3. Ulota lutea (Hook.f. & Wilson) Mitt., *J. Proc. Linn. Soc., Bot.* 4: 77 (1860)

Orthotrichum luteum Hook.f. & Wilson, *in* J.D.Hooker, *Fl. Tasman.* 1: 184 (1856). T: rivulet behind Cummings Head, Western Mountains, Tas., *W.Archer*; holo: H-BR; iso: HO.

Ulota weymouthii Burchard, *Pap. & Proc. Roy. Soc. Tasmania* 1893: 200 (1894). T: Falls Track, Mt Wellington, Tas., 1891, *W.A.Weymouth 615*; holo: H-BR; iso: HO.

Ulota lutea var. *glaucescens* Venturi ex Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 8 (1906). T: McRobies Gully, near Hobart, Tas., 13 Aug. 1892, *W.A.Weymouth 1532*; holo: TR; iso: HO.

Ulota crocea Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 96 (1906), *nom. nud.*

Autoicous. Plants forming cushions or tufts, 10–25 mm tall, bright green to yellow-green or brown above, brown below. Stems erect. Leaves strongly crisped, twisted and contorted when dry, imbricate, spreading when moist, long, linear-lanceolate, 1.5–2.3 mm long, c. 0.4 mm wide, abruptly widened to a concave, ovate or obovate base; apex short-acuminate; margin entire, recurved just above base, forming an indentation; costa ending just below apex; upper laminal cells irregularly isodiametric, 9–13 µm wide; basal laminal cells long, narrow, 36–60 × 6 µm, with sigmoid lumina, the margins with 2–5 rows of quadrate cells. Perichaetial leaves broader and more obtuse at base than stem leaves. Setae 3–6 mm long, yellow. Capsules narrowly cylindrical, 1–2 mm long, rarely shorter, 8-ribbed from mouth to base of urn; neck long, smooth, tapering, often twisted with seta when dry; stomata in neck of capsule; rim of operculum not coloured. Peristome with exostome segments transversely barred in upper part of the ventral surface, recurved when dry, pale, papillose; endostome segments 8, rarely with 8 intermediate ones, filiform, smooth, finely papillose, hyaline. Spores unicellular, 22–30 (–34) µm diam., densely papillose. n = 11, *fide* H.P.Ramsay, *J. Hattori Bot. Lab.* 74: 189 (1993).

A southern-temperate species in Vic. and Tas.; widely distributed in New Zealand.

This is the most frequently collected species of *Ulota* in Australia. It is variable in leaf shape and size, and in the form of the capsules and peristome. The usually narrow, hyaline leaf border varies in width and is not always conspicuous. The abruptly recurved margin and indentation just above the widened base is distinct, and specimens are readily identified where this is combined with capsules having long, smooth, tapered necks. The necks often become twisted with the setae, but they are smooth and not ribbed as is the urn of the capsule.

Malta (*op. cit.* 5) based his description on a number of Weymouth collections from H-BR in addition to the type. Duplicates of some of these, *Weymouth 1535*, *1539* (as *U. lutea*) and *Weymouth 615* (as *U. weymouthii*) are present in HO.

A.J.Fife (pers. comm.) has a much broader concept of *Ulota lutea* based on studies of New Zealand material and places *U. laticiliata* into synonymy, a decision not followed here.

Two varieties, in addition to the type variety of *U. lutea*, were listed by Malta (*op. cit.* 5). After studying “very scanty material”, he concluded that “*U. lutea* var. *glaucescens*” (Malta, *op. cit.* 8) does not belong to *U. lutea* but is possibly *U. viridis*. However, a good Weymouth specimen (*1532*) labelled “n. sp.” at HO is clearly a slightly glaucous form of *U. lutea* but not distinct enough to be considered a separate variety. A second variety, var. *robusta*, listed as a form by Malta (*op. cit.* 6), is here considered to be distinct from the type variety.

Plants forming medium-sized cushions, 10–15 mm tall, bright green to yellow-green above, brown below; leaves to 1.5–2.0 mm long; setae 3–6 mm long; capsules 1–2 mm long, with long exostome teeth .... **3a.** var. **lutea**

Plants robust, in large tufts, 15–25 mm tall, brown above; leaves 2.0–2.3 mm long; setae to 3 mm long; capsules to 1 mm long, with short exostome teeth .... **3b.** var. **robusta**

3a. Ulota lutea (Hook.f. & Wilson) Mitt. var. **lutea**

Illustrations: N.Malta, *Acta Horti Bot. Univ. Latv.* 7: 2, fig. 1a; 6, fig. 2; 8, fig. 3 (1933); S.J.Jarman & B.A.Fuhrer, *Mosses and Liverworts of Rainforest in Tasmania and South-eastern Australia* 51, fig. 33 (1995).

Plants forming cushions, 10–15 mm tall, bright green to yellow-green above, brown below. Leaves to 2 mm long; hyaline border 2–5 cells wide. Setae 3–6 mm long. Capsules 1–2 mm long, with a long tapering neck. Peristome with a long endostome. Fig. 28U–DD, Plate 25.

Occurs in Vic and Tas.; also in New Zealand. Epiphytic on branches and twigs in humid forest. Map 115.

Vic.: Errinundra Flora Reserve, S of Bendoc, *H.Streimann 36619* (CANB). Tas.: Bower Ck, Mt Wellington, *W.A.Weymouth 1535* (HO); Mount Field Natl Park, *J.R.Spence 4595* (NSW); Zig Zag Hill, SW of Mt Sedgwick, West Coast, *A.Moscal 20214* (HO).

3b. Ulota lutea var. **robusta** Dixon ex Malta, *Acta Horti Bot. Univ. Latv.* 7: 6 (1933)

T: L. Belcher, Tas., *L.Rodway*; holo: BM; iso: HO.

Plants in robust brown tufts, 15–25 mm tall. Leaves 2.0–2.3 mm long, with a narrow hyaline basal border 2–5 cells wide above the base. Setae to 3 mm long. Capsules less than 1 mm long, with short exostome teeth.

Endemic to Tas. Map 116.

Tas.: Hartz Mtns, *L.Rodway s.n.* (HO); L. Belcher, *L.Rodway s.n.* (HO).

This is not just a large form of *Ulota lutea*, but a distinct variety that forms tufts rather than cushions and has a shorter seta, smaller capsules and shorter endostome teeth.

Dixon's notes on the isotype packet in HO state that "I have not seen this species so robust before but I have N.Z. & Tasmanian specimens quite approximating to it. H.N.Dixon 9 Aug. 1921." However, var. *robusta* is a Tasmanian endemic, and it does not occur in New Zealand.

4. Ulota membranata Malta, *Acta Horti Bot. Univ. Latv.* 7: 18 (1933)

T: Comet–Dundas road, West Coast, Tas., 17 Oct. 1893, *W.A.Weymouth 1652* (annotated 'W.A.W. 22'); holo: H-BR; iso: HO, TR.

Illustrations: N.Malta, *op. cit.* 18, fig. 9 (1933); G.O.K.Sainsbury, *op. cit.* pl. 35, fig. 2 (1955).

Autoicous. Plants tufted, 10–15 mm tall, yellow-brown to yellow-green, dark below. Stems erect. Leaves slightly twisted, not crisped when dry, spreading when moist, linear-lanceolate, 1.5–2.0 mm long, gradually narrowing from a concave obovate base; apex acuminate; margin plane, entire; costa ending below or in apex; upper laminal cells isodiametric, 8–10 µm wide, smooth; basal laminal cells yellow, the border 4–6 rows wide. Gemmae not seen. Perichaetial leaves with a longer base, usually more obtuse than stem leaves. Setae gradually thickened above, 3–4 mm long, yellowish. Capsules subpyriform, 1.0–1.5 mm long, broad, narrowed at the mouth, strongly ribbed, little-altered when dry; stomata in lower part of urn. Peristome with prostome formed by somewhat irregular slightly striated membranes, sometimes reaching as high as the middle of the exostome; exostome teeth yellow, with distinct transverse bars, splitting when old; endostome segments 16, broad, irregular. Spores mostly multicellular, very large, to 70–90 µm diam., smooth, yellowish green. Chromosome number not known. Fig. 29W–GG.

A rare epiphyte in Tas.; also in New Zealand. Map 117.

Tas.: Cradle Mtn, Dec. 1915, *L.Rodway* (HO); Adamsons Peak, 2 Mar. 1980, *A.V.Ratkowsky s.n.* (HO).

The isotype in HO has the number *W.A.W. 22* on the inside packet as well as the published number *W.A.W. 1652*; it was originally incorrectly identified as *U. viridis*. An additional isotype, similarly misidentified, was located in TR.

The presence of a prostome, large multicellular spores and subpyriform, strongly ribbed capsules with a narrow mouth are distinguishing features. Pre-germinated spores with several radiating protonemata have been found in mature capsules.

5. Ulota viridis Venturi, *in* V.F.Brotherus, *Oefvers Förh. Finska Vetensk.-Soc.* 35: 43 (1893)

T: near springs, Mt Wellington, Tas., 15 Oct. 1890, *W.A.Weymouth 901*; holo: TR; iso: HO.

Ulota anceps Venturi, *in* V.F.Brotherus, *Oefvers Förh. Finska Vetensk.-Soc.* 35: 42 (1893). T: Springs to Ferntree, Mt Wellington, Tas., 7 Mar. 1891, *W.A.Weymouth 900*; holo: H-BR; iso: HO.

Ulota appressa Mitt. ex Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 96 (1906), *nom. inval.* (in synon.).

Autoicous. Plants spreading, 10–25 mm long, in flat yellowish green or greyish green tufts. Stems usually creeping, with dense erect branches. Leaves appressed and slightly twisted, with projecting apices when dry, linear-lanceolate or lanceolate, 1.0–2.1 mm long, expanding to an ovate or oblong base; apex narrowly acuminate to acute; margin plane or slightly recurved in middle mostly on one side; costa ending below apex; upper laminal cells irregularly isodiametric, 9–11 µm wide; basal laminal cells almost vermicular; basal marginal cells in 1–6 rows. Perichaetial leaves variable, often with an obtuse apex, usually with a broader somewhat sheathing base. Setae 3.0–3.5 (–5.5) mm long. Capsules oblong or subcylindrical, less than 1.5 mm long, when empty contracted at mouth and finely ribbed to the top of the short neck; stomata in lower part of urn; operculum with a yellow rim. Peristome with exostome teeth recurved when dry, yellow; endostome segments 8, filiform, smooth, hyaline. Spores unicellular, 24–32 µm diam., finely papillose, brown or yellowish. Chromosome number not known for Australia; n = 11 (New Zealand), *fide* H.P.Ramsay, *J. Hattori Bot. Lab.* 74: 188 (1993).

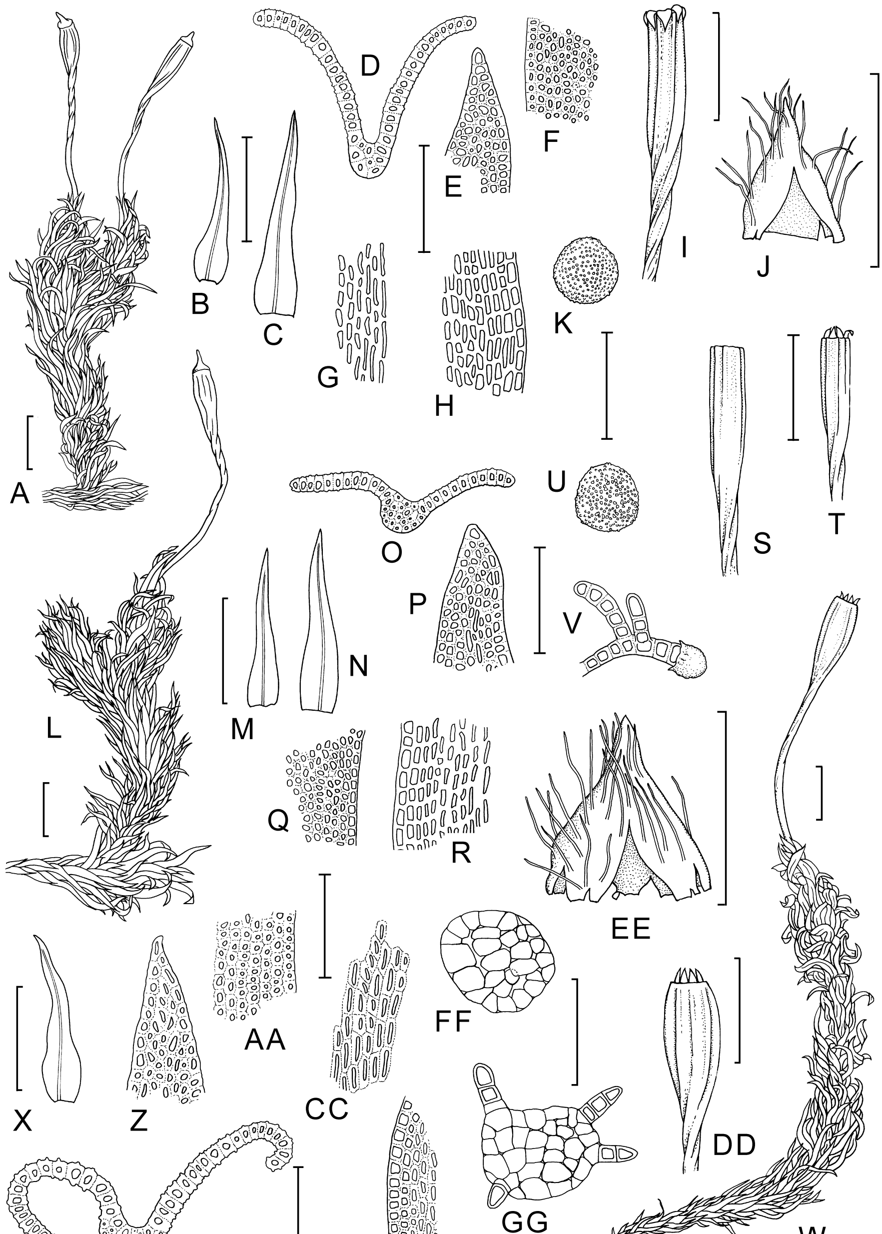
This species is characterised by the usually creeping stems and the small branch leaves with comparatively broad bases, mostly appressed and little-altered when dry.

Malta (*op. cit.* 21–22) examined a number of Weymouth collections, some of which have isotypes in HO with earlier names, e.g. *U. anceps* (*W.A.Weymouth 900*) published simultaneous with *U. viridis*, and *U. appressa* (*W.A.Weymouth 1547*). Although Malta reported *U. anceps* as being a robust form of *U. viridis*, comparison of the types shows them to be very similar in size. No type specimen of *U. anceps* was located at TR.

One noteworthy specimen labelled *Ulota appressa* Mitt. "on wood Guy Fawkes Rivulet, near Hobart, Tasmania, 6/9/1890 *W.A.Weymouth 1547*" (HO) is annotated "BM, = *U. anceps* Venturi n. sp.". This may be part of the specimen named but never published by Mitten. It is not, however, the type specimen of *U. anceps*, described later in 1893. An additional annotation reads "Vent. in litt. 1896" indicating Venturi's opinion that it was a synonym of *Ulota anceps*. H.N.Dixon (*Bull. New Zealand Inst.* 3(6): 366, 1929) examined two New Zealand specimens collected by Bell and annotated by Mitten with the *nomen nudum U. appressa*, but with an incorrect reference to Tasmania.

There are two varieties of *U. viridis* in Australia, var. *viridis* and var. *dixonii*; the latter was previously recognised as a distinct species.

Figure 29 (opposite). *Ulota*. **A–K**, *U. viridis* var. *viridis*. A, Habit (dry specimen) with capsules with opercula; **B**, Leaf; **C**, Perichaetial leaf; **D**, T.S. of vegetative leaf; **E**, Apical leaf cells; **F**, Midleaf cells; **G**, Marginal hyaline basal cells; **H**, Mid-basal cells; **I**, Capsule showing peristome; **J**, Calyptra; **K**, Spore (A, J, K, *W.A.Weymouth 537a*, HO; B–H, isotype, HO; I, J, *J.A.Curnow 26043*, HO). **L–V**, *U. viridis* var. *dixonii*. **L**, Habit (dry specimen) with capsule and operculum; **M**, Leaf; **N**, Perichaetial leaf; **O**, T.S. of vegetative leaf; **P**, Apical leaf cells; **Q**, Mid-leaf cells; **R**, Marginal hyaline basal cells; **S**, Capsule without peristome; **T**, Capsule with peristome; **U**, Spore; **V**, Germinating spore; (L–V, isotype). **W–GG**, *U. membranata*. **W**, Habit with an old empty capsule; **X**, Leaf; **Y**, T.S. of leaf; **Z**, Apical leaf cells; **AA**, Mid-leaf cells; **BB**, Marginal hyaline basal cells; **CC**, Mid-basal cells; **DD**, Capsule showing peristome; **EE**, Calyptra; **FF**, Multicellular spore; **GG**, Germinating spore (W, *L.Rodway s.n.*, HO; X–GG, isotype, HO). Scale bars: 1 mm for habit, calyptra, capsules and leaves; 100 µm for cellular drawings and FF; 50 µm for other spores. Drawn by D.Mackay and H.P.Ramsay.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Leaves 1–2 mm long, linear-lanceolate; leaf base ovate with a border of 4–6 rows of hyaline cells; upper leaves appressed and slightly twisted, with projecting apices when dry .... **5a.** var. **viridis**

Leaves 1.5–2.1 mm long, lanceolate; leaf base oblong with a border of 1–3 rows of hyaline cells; upper leaves appressed but slightly twisted; apices straight, not projecting when dry .... **5b.** var. **dixonii**

5a. Ulota viridis Venturi var. **viridis**

Illustration: N.Malta, *Acta Horti Bot. Univ. Latv.* 7: 21, fig. 11 (1933).

Plants tufted to creeping, 10–15 mm long; branches short, 3–5 mm long. Branch leaves linear-lanceolate, 1–2 mm long, with an ovate base and a basal border of 4–6 rows of hyaline cells; upper branch leaves appressed and slightly twisted, with projecting apices when dry. Setae 3–5 mm long. Capsules oblong, with a short tapering neck, finely ribbed when dry. Spores with minute papillae. Fig. 29A–K.

Epiphytic in Vic. and Tas. at altitudes above 900 m; widespread in New Zealand. Map 118.

Vic.: Mt Ellery, Errinundra Natl Park, 29 km SSW of Bendoc, *H.Streimann 47969*, *47958* (CANB). Tas.: Springs Track, Mt Wellington, *W.A.Weymouth 537* (HO).

5b. Ulota viridis var. **dixonii** (Malta) H.P.Ramsay, *Fl. Australia* 51: 411 (2006)

Ulota dixonii Malta, *Acta Horti Bot. Univ. Latv.* 7: 19 (1933). T: Hartz Mtns, Tas., 7 Jan. 1908, *W.A.Weymouth s.n.* (annotated "WAW 2299"); holo: H-BR; iso: HO.

Illustration: N.Malta, *op. cit.* 20, fig. 10 (1933), as *Ulota dixonii*.

Plants tufted; stems creeping, 20–25 mm long, with erect branches 8–13 mm tall, branching towards apex. Branch leaves appressed, not twisted when dry, lanceolate, 1.5–2.1 mm long, with an oblong base; apices straight, not projecting when dry. Stem leaves 1.5–2.1 mm long; marginal basal cells hyaline, in 1–3 rows. Setae to 5.5 mm long. Capsules subcylindrical, scarcely ribbed when dry. Spores with large papillae. Fig. 29L–V.

Endemic to Tas. where it is epiphytic on the limbs of trees. Map 119.

Tas.: Golden Staircase Track, L. Dobson, Mount Field Natl Park, 7 Dec. 1988, *B.Polly s.n.* (HO).

Included with one of the isotypes is a specimen of *U. lutea* which accounts for the original identification of it as *U. lutea* in the H-BR collection (Malta 1933, p. 20).

This variety is similar to var. *viridis* in the creeping stems, the slightly twisted dry leaves and the yellow-bordered capsule rim. However, it differs in being larger and more robust, paler above, and with larger, lanceolate stem leaves that taper gradually from oblong bases. The border of hyaline cells also narrower (1–3 rows wide; 4–6 rows in var. *viridis*). Malta (1933) considered the spores of *U. dixonii* to be distinctly verrucose compared with the papillose spores of *U. viridis*, this being the principal difference between the two. These should be regarded as varieties of *U. viridis* rather than as separate species.

G.O.K.Sainsbury (*Bull. Roy. Soc. New Zealand* 5: 223, 1955) described *U. novae-seelandiae* Sainsbury from New Zealand with affinities to "*U. dixonii*". The former also has a creeping habit, leaves that are appressed and scarcely twisted when dry, but the hyaline border is broader, the operculum has a red rather than yellow rim, and the spores are smaller. A.J.Fife (pers. comm.; *Bryologist* 98: 331, 1995) synonymised *U. novae-seelandiae* with *U. viridis*.

Excluded Names

Ulota glaucescens Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 96 (1906), *nom. nud.*

Ulota stellulata Hook. & Grev. ex Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 97 (1906), *nom. nud*.

Based on: Mt Ellery [Mt Elliot], Gippsland, Vic., *coll. unknown*; MEL.

8. ZYGODON

Jette Lewinsky-Haapasaari† *& Helen P. Ramsay*[1]

Zygodon Hook. & Taylor, *Musc. Brit.* 70 (1818); from the Greek *zygo* (yoked) and *odontos* (a tooth), in reference to the peristome teeth that are initially paired.

Type: *Z. conoideus* (Dicks.) Hook. & Taylor

Amphidium Nees, *in* J.Sturm, *Deutschl. Fl.* 2: 17 (1819), *nom. rej. non Amphidium* Schimp.; *Zygodon* sect. *Amphidium* (Nees) Müll.Hal., *Linnaea* 18: 668 (1845). T: *Zygodon forsteri* (Brid.) Mitt.

Dioicous, autoicous or synoicous. Plants in loose tufts. Stems erect to ascending, simple or sparsely branched. Rhizoids at stem base, frequently matted, smooth. Leaves flexuose or twisted when dry, lanceolate to ovate-lanceolate, entire or denticulate near the acute (rarely obtuse) apex; margin plane or recurved below; costa almost reaching apex or excurrent; upper laminal cells isodiametric (hexagonal-rounded), papillose or smooth; basal laminal cells rectangular, smooth. Gemmae on stems or in leaf axils, small, cylindrical or fusiform. Perichaetial leaves differentiated or not. Calyptra small, cucullate, smooth, glabrous or rarely hairy. Setae long. Capsules on main stem, long-exserted, ovoid to cylindrical or pyriform, with 8 longitudinal striae when dry; stomata superficial on capsule neck; operculum obliquely long-rostrate from a low-conical base. Peristome double, single or absent; exostome teeth 16, initially joined in pairs, lanceolate, papillose; endostome segments 8 or 16, linear, papillose to striate. Spores unicellular, isomorphic, globose.

A genus of c. 77 species as circumscribed by Malta (1926), re-estimated as c. 52 species by Vitt (*Beih. Nova Hedwigia* 71: 261–268, 1982). Distributed worldwide, but most diverse in temperate regions. The genus is represented in Australia by six non-endemic species of which two, *Z. minutus* and *Z. hookeri*, occur only in Australasia. *Zygodon* is an important element in the epiphytic and epilithic floras of south-eastern and south-western Australia. Tasmania has six species, Victoria four and Western Australia three species.

Although the genus is not host-specific, usually only one species will be found on a particular tree species at a given location; in contrast, species of *Orthotrichum* or *Ulota* often grow in mixed colonies. *Zygodon intermedius*, the most widespread taxon in Australia and New Zealand, has been recorded from 47 phorophytes.

Malta (1926) recognised four sections based on gametophyte characters: *Euzygodon* Müll.Hal. (*Zygodon* sect. *Zygodon*), *Stenomitrium* Mitt., *Bryoides* Malta and *Obtusifolia* Malta. Sect. *Zygodon* is the largest section (represented in Australia by *Z. intermedius* and *Z. hookeri*), and it includes species with leaves in five ranks, smooth laminal cells and obtuse leaves. Sect. *Obtusifolia* is represented by *Z. obtusifolius*, and sect. *Bryoides* by *Z. gracillimus*, *Z. menziesii* and *Z. minutus*. Sect. *Stenomitrium* is sometimes regarded as a separate genus (Brotherus, *Nat. Pflanzenfam*. I, 3: 464–465, 1902; Vitt, *loc. cit.*), but it is not known from Australia.

Although Lewinsky (1990) revised *Zygodon* in Australia, there has not been a worldwide revision since that of Malta (1926). In a cladistic study based on rbcL sequences that was aimed mainly at circumscribing the Orthotrichaceae and reconstructing relationships between the genera, Goffinet & Vitt (1998) found *Zygodon* to be polyphyletic. They described a new genus *Bryomaltea* for *Z. obtusifolius* in a clade with *Macromitrium* and related genera. Another clade with *Z. pungens* was resolved as sister to or in trichotomy with two other representatives of *Zygodon* in addition to *Orthotrichum* and *Ulota*. Goffinet & Vitt (1998) reintroduced the genus *Codonoblepharon* Schwägr. with *Z. menziesii* as type and including *Z. minutus*.

[1] c/- National Herbarium of New South Wales, Royal Botanic Gardens and Domain, Mrs Macquaries Road, Sydney, New South Wales 2000.

This present work follows the death of Lewinsky (November 1998) on whose research this revision is based. Pending a wider revision of the genus, Lewinsky's concepts are retained here for the Australian species.

N.Malta, Die Gattung *Zygodon* Hook. et Tayl. Eine monographische Studie, *Acta Horti Bot. Univ. Latv.* 1: 1–184 (1926); J.Lewinsky, *Zygodon* Hook. & Tayl. in Australasia: a taxonomic revision including SEM-studies of peristomes, *Lindbergia* 15: 109–139 (1989); B.Goffinet & D.H.Vitt (1998), Revised generic classification of the Orthotrichaceae based on a molecular phylogeny and comparative morphology, *in* J.W.Bates, N.W.Ashton & J.G.Duckett (eds), *Bryology for the Twenty-first Century* 143–159 (1998).

1 Upper laminal cells smooth 2

1: Upper laminal cells papillose.......... 4

2 Costa usually excurrent, rarely percurrent; stems in cross-section with uniformly thin-walled cells *(1)* .... **5. Z. minutus**

2: Costa ending below apex; stems in cross-section with at least some of the cortical cells thick-walled.......... 3

3 Plants yellow-green; costa strong; leaves 0.3–0.6 mm long, usually plane with flat margins *(2:)* .... **1. Z. gracillimus**

3: Plants olive-green to dark green-brown above, brown or brown-black below; costa less well defined; leaves 1.0–1.6 (–2.1) mm long, slightly undulate, mostly with margins recurved to revolute in central part.......... **4. Z. menziesii**

4 Leaf apices obtuse; plants to 10 mm tall; leaves to 1 mm long *(1:)* ....**6. Z. obtusifolius**

4: Leaf apices acute or short-acuminate; plants to 55 mm tall; leaves to 2.4 mm long.......... 5

5 Dioicous; perichaetial leaves lanceolate, with an acute apex; leaves rarely denticulate near apex, with teeth formed only by part of a cell; seta 2.5–10 mm long; capsules 1.0–1.5 mm long; spores 13–20 µm diam. *(4:)*.......... **3. Z. intermedius**

5: Synoicous; perichaetial leaves ovate to lanceolate, with an acuminate apex; leaves often dentate, with teeth formed by entire cells; seta 10–15 mm long; capsules 1.5–2.0 mm long; spores 20–25 µm diam. .... **2. Z. hookeri**

1. Zygodon gracillimus Broth. ex M.Fleisch., *Musc. Buitenzorg* 2: 392, fig. 73 (1904)

T: Handang-Badak, Indonesia; lecto: FH, *fide* J.Lewinsky, *Lindbergia* 15: 123 (1989).

Zygodon rodwayi Broth., *in* L.Rodway, *Pap. & Proc. Roy. Soc. Tasmania* 1913: 260 (1914). T: Forth R., near Sheffield, Tas., *L.Rodway 106*; holo: H; iso: NSW, WELT.

Illustrations: J.Lewinsky, *op. cit.* 15: 114, figs 21–26; 122, figs 57–76 (1989).

Dioicous. Plants in dense yellow-green tufts, very slender. Stems fastigiately branched, thin, with some thick-walled cortical cells in cross-section. Rhizoids well developed near stem base. Leaves appressed when dry, spreading to erect-spreading when moist, lanceolate, 0.3–0.6 mm long, 0.1–0.2 mm wide; apex acute; margin plane, entire or somewhat crenulate near apex; costa strong, ending below apex, 25–45 µm wide near base, pale; upper laminal cells rhomboidal, 4–12 × 3–9 µm, thick-walled, smooth, almost quadrate near margins; basal laminal cells irregular, rectangular to rhomboidal, thick-walled. Gemmae clavate, with transverse walls only, 3–7 cells, 30–110 µm long. Perigonium terminal or pseudolateral. Perichaetial leaves somewhat longer than stem leaves. Calyptra fugacious, smooth. Setae long. Capsules long-exserted, pyriform with a long neck, deeply ribbed along entire length when dry, pale to reddish brown; mouth surrounded by 2–4 rings of quadrate thick-walled cells; exothecial cells rectangular, rarely quadrate, differentiated into 8 bands of broader ±yellow cells; stomata few, on neck only. Peristome double; fragmentary prostome sometimes present; exostome teeth 8 pairs, reflexed when dry, hyaline to pale yellow; endostome segments 8 or 16, 67–75% the height of the exostome, hyaline. Spores 12.5–14.0 µm diam., finely papillose. Chromosome number not known. Fig. 30R–Z.

Known from Tas.; also in New Zealand, Java and Bolivia. Epiphytic on trees. Map 120.

Tas.: Forth R., near Sheffield, *L.Rodway 106* (HO, NSW); Forth R., N coast, *L.Rodway 2492* (HO); Kingston-Longley, *L.Rodway s.n.* (HO); Sumac Rd, 9 Oct. 1993, *J.Jarman s.n.* (HO).

This species is characterised by its long, clavate gemmae.

Goffinet & Vitt (1998: 150) referred this species to *Codonoblepharum* Schwägr.

2. **Zygodon hookeri** Hampe, *Linnaea* 30: 632 (1860)

T: Grampians, [Vic.], 1854, *F.Mueller*; holo: BM.

[*Zygodon reinwardtii auct. non* Schwägr.: L.Rodway, *Pap. & Proc. Roy. Soc. Tasmania* 1913: 58 (1914)]

[*Zygodon anomalus auct. non* Dozy & Molk.: L.Rodway, *Pap. & Proc. Roy. Soc. Tasmania* 1913: 58 (1914)]

Illustrations: J.Lewinsky, *Lindbergia* 15: 116, figs 31–33; 134, figs 156–175 (1989).

Synoicous. Plants in loose tufts or mats, 10–30 mm tall, green to yellowish green above, red-brown or brown below. Stems branched. Rhizoids extending up stems. Leaves crisped, flexuose and loosely curled around stem when dry, spreading or somewhat recurved when moist, lanceolate or linear-lanceolate, 1.4–2.4 mm long, 0.5–1.2 mm wide; apex sharply acute; base slightly decurrent; margin ±undulate, often dentate, with teeth formed by whole cells; costa ending below apex or, rarely, percurrent and broadened at apex; upper laminal cells irregularly arranged, isodiametric, 6.0–12.5 × 4.5–11.0 µm, thick-walled, with 3–6 short papillae per cell. Gemmae rare, small, clavate, 3-celled, green with hyaline walls. Perichaetial leaves ovate-lanceolate, with acuminate apices. Calyptra smooth. Setae 10–15 mm long. Capsules oblong or cylindrical, 1.5–2.0 mm long, with 8 deep ribs along entire length when dry. Peristome single; exostome absent; endostome segments 8, rarely 16, filiform, smooth, hyaline. Spores 20–25 µm diam., papillose. Chromosome number not known. Fig. 31I–P.

Local in southern N.S.W., southern and south-western Vic. and Tas.; also in New Zealand. Occurs at elevations of 400–1000 m, most commonly as an epiphyte (often on trunks of *Nothofagus* in wetter areas) and occasionally on rocks. Map 121.

N.S.W.: Deep Ck, Batlow, *W.W.Watts 7631* (NSW). Vic.: Mt William, Grampians, *H.Streimann 3031* (CANB). Tas.: Mt Wellington, *W.A.Weymouth 3049* (HO); Forth R., *L.Rodway 2492* (HO); Great L., *D.H.Norris 33028* (HO).

This species can be separated from *Z. intermedius* by the more open habit, the more twisted and undulate leaves and longer setae, synoicous rather than dioicous reproduction, larger spores, longer capsules and differences in the perichaetial leaves. The two species also differ in their ecology and distribution; *Z. hookeri* occurs in wetter habitats and is endemic to Australasia, whereas *Z. intermedius* tolerates a wider ecological amplitude and is more widespread.

3. **Zygodon intermedius** Bruch & Schimp., *Bryol. Eur.* 3: 41 (1838)

T: “Dusky Bay” [Dusky Sound], New Zealand, 1791, *A.Menzies*; holo: BM.

Zygodon brownii Schwägr., *Sp. Musc. Frond.*, Suppl. 4: 317 (1842). T: Terra van Diemen [Tas.], *R.Brown*; holo: G.

Zygodon brachyodus Müll.Hal. & Hampe, *in* G.Hampe, *Linnaea* 28: 210 (1856). T: Sealers Cove, Vic., *F.Mueller*; holo: BM; iso: H.

Zygodon confertus Müll.Hal., *Hedwigia* 37: 134 (1898). T: Vic., *F.M.Campbell*; lecto: H, *fide* J.Lewinsky, *Lindbergia* 15: 132 (1989).

Zygodon hymenodontoides Müll.Hal., *Hedwigia* 37: 135 (1898), *nom. illeg.* T: Moe R., Gippsland, Vic., *J.G.W.Luehmann*; lecto: H, *fide* J.Lewinsky, *Lindbergia* 15: 132 (1989).

Illustrations: J.Lewinsky, *Lindbergia* 15: 116, figs 27–30; 131, figs 131–153 (1990); R.D.Seppelt, *The Moss Flora of Macquarie Island* 212, fig. 84 (2004).

Dioicous. Plants in ±dense tufts or mats, 5–25 (–55) mm tall, green to yellowish green above, red-brown to brown below. Stems frequently branched. Rhizoids at stem bases. Leaves loosely twisted around stem or erect-appressed when dry, erect, open or spreading when moist, lanceolate or linear-lanceolate, 0.6–1.8 mm long, 0.2–0.3 mm wide; apex acute; base somewhat decurrent; margin plane or somewhat undulate, entire or rarely denticulate near apex, with teeth formed by part of cell; costa ending below apex; upper laminal cells ±isodiametric, 4–10 (–15) µm wide, thin- or thick-walled, with 5–8 short papillae per cell;

basal laminal cells rounded-rectangular, 9–50 µm long. Gemmae occasional, small, clavate, 3-celled, with hyaline walls. Perigonium terminal or sublateral. Perichaetial leaves lanceolate, with acute apices. Calyptra smooth. Setae 2.5–10.0 mm long. Capsules exserted, pyriform, oblong or cylindrical, 1.0–1.5 mm long, with 8 deep ribs along entire length when dry. Peristome double; exostome teeth 8, short, sometimes reduced or absent; endostome segments 8, ±reduced, hyaline. Spores 13–17 (–20) µm diam., papillose. n = 11 (10 + m), *fide* H.P.Ramsay, *J. Hattori Bot. Lab*. 74: 189 (1993). Fig. 31A–H.

Occurs in south-western W.A., S.A., northern and south-eastern Qld, N.S.W., A.C.T., Vic. and Tas.; also a widespread species in New Zealand, South America, Africa and Asia. Most common from sea level to 1500 m, usually epiphytic, but also found on rock. Grows on a wide range of trees and shrubs and tolerates great differences in humidity, although it is absent from the driest habitats. Map 122.

W.A.: Beedelup Falls, NW of Pemberton, *W.A.Weber B33.579* (AD). S.A.: Mt Lofty, *D.G.Catcheside 55.28* (AD). Qld: Killarney, *I.G.Stone 14610* (MEL). N.S.W.: Reservoir Gully, Yarrangobilly Caves, *W.W.Watts 8670* (NSW). A.C.T.: Bendora Rd, Brindabella Ra., *W.B.Schofield 90839 & 90603* [*with H.Streimann, H.P.Ramsay & M.I.Schofield*] (NSW). Vic.: Mt William, Grampians, *H.Streimann 3047* (CANB). Tas.: Mt Dobson Rd, *H.P.Ramsay R1862* (NSW).

The small, 3-celled gemmae are especially distinctive.

4. **Zygodon menziesii** (Schwägr.) Arn., *Disp. Méth. Mousses* 15 (1826)

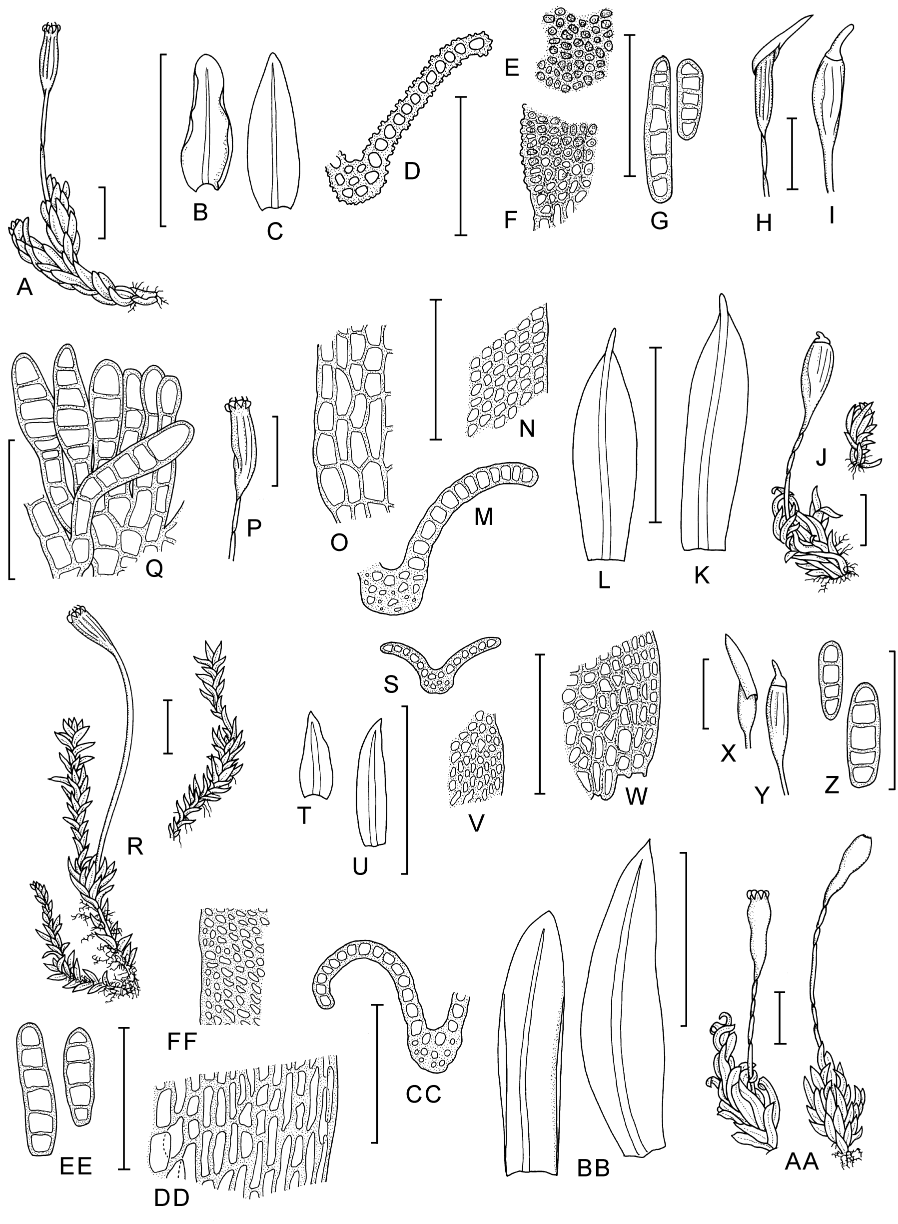
Codonoblepharum menziesii Schwägr., *Sp. Musc. Frond.*, Suppl. 2, 1: 142 (1824). T: “Dusky Bay” [Dusky Sound], New Zealand, 1791, *A.Menzies s.n.*; holo: G.

Zygodon drummondii Taylor, *London J. Bot*. 5: 46 (1846). T: Swan R., [W.A.], 1843, *J.Drummond s.n.*; lecto: BM, *fide* J.Lewinsky, *Lindbergia* 15: 126 (1989); isolecto: H, L.

Illustrations: J.Lewinsky, *Lindbergia* 15: 113, figs 15–20; 127, figs 100–111; 128, figs 112–128 (1990); R.D.Seppelt, *The Moss Flora of Macquarie Island* 213, fig. 85 (2004).

Dioicous. Plants densely tufted, to 10 mm tall, olive-green to dark green-brown above, brown below. Stems branched, with some thick-walled cortical cells in cross-section. Rhizoids extending up stem. Leaves firmly twisted around stem or loosely twisted with a twisted apex when dry, usually erect-open when moist, lanceolate to ovate-lanceolate, slightly undulate, often keeled above, 1.0–1.6 (–2.1) mm long, 0.3–0.5 (–0.7) mm wide, not decurrent; apex acute or rounded-acute; margin entire, recurved to revolute in lower 33–67%; costa not strong, ending below apex; upper laminal cells often in oblique rows, quadrate or rhomboidal, 9–12 × 6–12 µm, walls ±thick; basal cells rectangular, 20–45 (–60) × 12–20 µm, thin-walled near costa, thick-walled near margin, smooth. Gemmae filiform to clavate, 4–8-celled, 45–150 µm long, the walls transverse, green or brownish. Perigonium pseudolateral.

Figure 30 (opposite). *Zygodon*. **A–I**, *Z. obtusifolius*. **A**, Dry plant with mature capsule; **B**, Stem leaf; **C**, Perichaetial leaf; **D**, T.S. of leaf (*S.Berggren 1029*, C); **E**, Upper laminal cells; **F**, Basal laminal cells; **G**, Gemmae; **H**, Capsule with calyptra; **I**, Capsule with operculum (A–D, E–I, Bay of Islands, N.Z., 1841, C). **J–Q**, *Z. minutus*. **J**, Dry male plant (right) and female plant with capsule (Hodgson, *Musci N.Z. Exicc. 21*, BM); **K**, Perichaetial leaf; **L**, Stem leaf (J (right), K, L, *Moore 605*, CHR); **M**, T.S. of leaf; **N**, Upper laminal cells; **O**, Basal laminal cells (M–O, *J.Lewinsky 1901*, C); **P**, Capsule with peristome (*J.Beever s.n.*, CHR); **Q**, Gemmae (*J.E.Beever et al. s.n.*, CHR). **R–Z**, *Z. gracillimus*. **R**, Dry female plant bearing capsule (left; *K.W.Allison 3466*, CHR) and male plant (*K.W.Allison 6734*, CHR); **S**, T.S. of leaf (*S.Berggren 2343*, WELT); **T**, Stem leaf; **U**, Perichaetial leaf (both *K.W.Allison 3472*, CHR); **V**, Upper laminal cells (*K.W.Allison 3466*, CHR); **W**, Basal laminal cells (*L.Rodway 106*, H); **X**, Capsule with calyptra; **Y**, Capsule with operculum (both *K.W.Allison 98*, CHR); **Z**, Gemmae (*K.W.Allison 6734*, CHR). **AA–FF**, *Z. menziesii*. **AA**, Plants bearing capsules (*A.Fife 5086*, CHR); **BB**, Stem leaves; **CC**, T.S. of leaf (both *J.E.Beever*, CHR 406735); **DD**, Basal laminal cells (*J.Lewinsky 1930*, C); **EE**, Gemmae (*G.O.K.Sainsbury 5215*, WELT); **FF**, Upper laminal cells (*A.Fife 5086*, CHR). Scale bars: 1 mm for habit, capsules and leaves; 100 µm for cellular drawings. Drawn by D.Mackay.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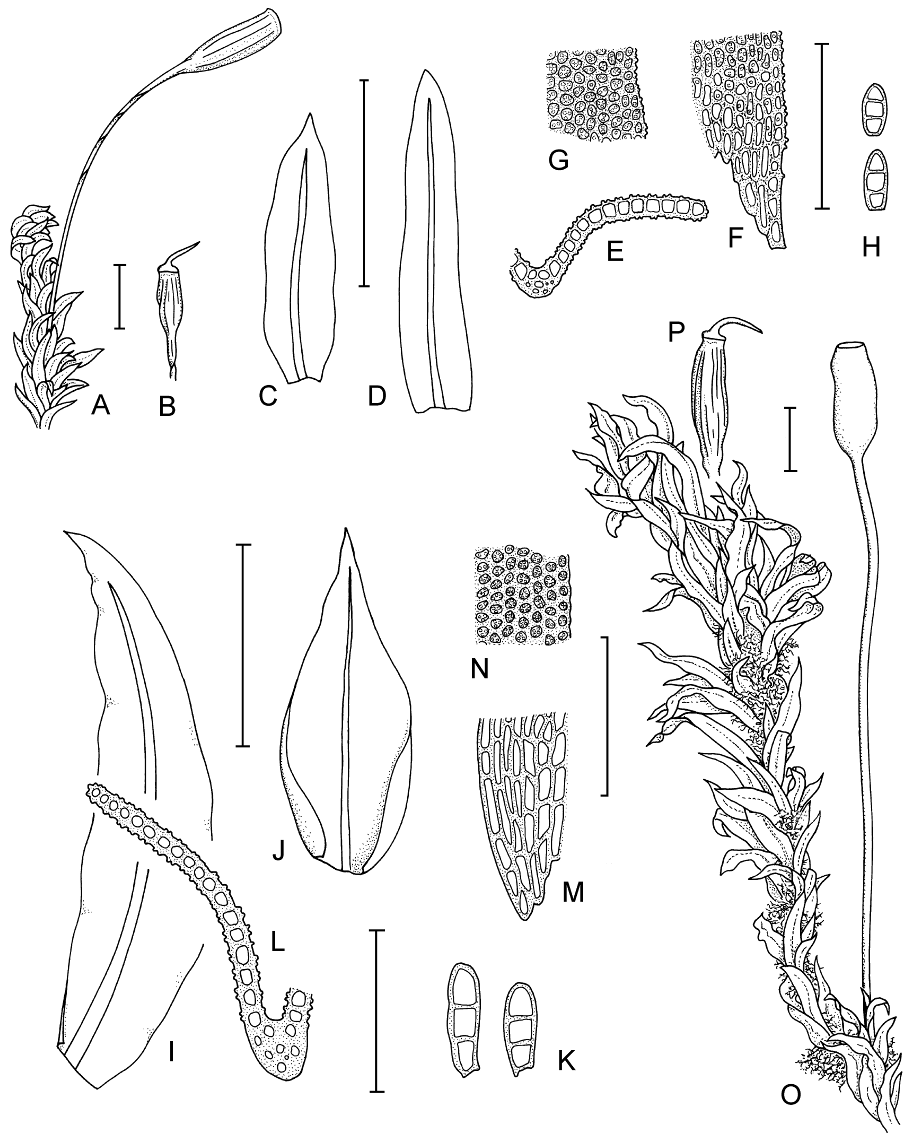

Figure 31. *Zygodon*. **A–H**, *Z. intermedius*. **A**, Dry plant with capsule; **B,** Capsule with operculum (*D.Glenny s.n.*, CHR); **C,** Stem leaf; **D**, Perichaetial leaf; **E**, T.S. of stem leaf; **F**, Basal laminal cells; **G**, Upper laminal cells; **H**, Gemmae (A, C–H, *D.H.Norris 33.945*, HSU). **I–P**, *Z. hookeri*. **I**, Stem leaf; **J**, Perichaetial leaf (both *I.G.Stone 9223*, MEL); **K**, Gemmae (*D.H.Norris 28.660*, HCC); **L**, TS. of stem leaf; **M**, Basal laminal cells; **N**, Upper laminal cells; **O**, Plant with capsule (L–O, *S.Berggren 1027*, C); **P**, Capsule with operculum (*J.Child 6583*, CHR). Scale bars: 1 mm for habit, capsules and leaves; 100 µm for cellular drawings. Drawn by D.Mackay.

Perichaetial leaves similar to vegetative leaves. Calyptra smooth. Setae 2.5–6.0 mm long. Capsules ovoid to pyriform or cylindrical, 1.5–2.0 mm long, deeply ribbed along entire length when dry, with a wide or, rarely, narrow mouth. Peristome double, well developed; exostome teeth 8 pairs, reflexed when dry, white to yellowish; endostome segments 8 or 16, half the height of the exostome, hyaline. Spores 15–18 µm diam., finely papillose. n = 11 (10 + m), *fide* H.P.Ramsay, *J. Hattori Bot. Lab*. 74: 189 (1993). Fig. 30AA–FF.

Occurs in south-western W.A., south-eastern S.A., eastern N.S.W., southern Vic. and Tas.; also in New Zealand, Stewart, Campbell, Auckland and Macquarie Islands and Chile. This is the only species found commonly on rock (basic and acidic), and it is also epiphytic on *Eucalyptus* spp. and introduced trees. It is known from sea level to 1500 m, and is tolerant of salt spray, being found on jetties and in mangrove swamps. Map 123.

W.A.: headwaters of Joshua Brook, 16 km E of Donnybrook, *D.H.Norris 25754* (NSW). S.A.: Tantaroola, *D.G.Catcheside 72.71* (AD). N.S.W.: Fitzroy Falls, *W.W.Watts 9802* (NSW). Vic.: Mt Buck, *Harrison 20* (NSW). Tas.: L. St. Clair, *D.A.Ratkowsky H775* (HO).

The gametophytes and sporophytes are rather variable; the most common form has brown or dark green leaves firmly twisted around the stems. In wetter areas, leaves can be loosely twisted around the stems and individually twisted at their apices. Gemmae are uniseriate and filiform to clavate. Specimens having gemmae with both transverse and longitudinal walls are referred to var. *angustifolium* Malta which is known only from New Zealand.

This species was treated as *Codonoblepharum menziesii* by Goffinet & Vitt (1998: 150).

5. Zygodon minutus Müll.Hal. & Hampe, *in* G.Hampe, *Linnaea* 28: 209 (1856)

T: Sealers Cove, Wilsons Promontory, Vic., *F.Mueller*; holo: BM, iso: NSW.

Illustrations: J.Lewinsky, *op. cit.* 112, figs 8–14; 124, figs 79–97 (1989).

Dioicous. Plants in dense tufts, olive-green to green above, red-brown below; female plants 1–3 mm tall; male plants smaller. Stems simple or branched, with thin-walled cortical cells in cross-section. Rhizoids well developed at stem base. Leaves flexuose when dry, erect-spreading when moist, lanceolate to ovate-lanceolate, 0.8–1.4 (–1.7) mm long, 0.2–0.4 mm wide; apex apiculate; base non-decurrent; margin plane or slightly reflexed near base, entire; costa usually excurrent, rarely percurrent or subpercurrent, 30–50 µm wide near base, yellowish or red-brown; upper laminal cells quadrate or rhomboidal, 6.0–12.5 × 7.5–15.0 µm, thick-walled, smooth; basal cells rectangular, 15–50 × 10–20 µm, thin-walled, smooth. Gemmae abundant, in clusters in leaf axils, clavate, 4–8-celled, 50–120 µm long, the walls hyaline. Perigonium terminal or pseudolateral. Perichaetial leaves undifferentiated. Calyptra smooth. Setae 1.5–3.0 mm long. Capsules exserted, broadly ovoid or pyriform, 1.0–1.5 mm long, ribbed when dry. Peristome double; prostome absent; exostome teeth in 8 pairs, reflexed when dry; endostome segments 8, sometimes with 8 rudimentary segments between, 50–67% the height of the exostome, hyaline. Spores 15–18 (–20) µm diam., finely papillose. n = 16 (New Zealand), *fide* H.P.Ramsay, *J. Hattori Bot. Lab*. 74: 189–190 (1993). Fig. 30 J–Q.

Occurs in south-western W.A., south-eastern S.A., south-eastern Qld, coastal Vic. and northern Tas. (including Flinders Is.); also in New Zealand. Epiphytic on living or dead trees or old posts, and often growing in bark fissures of *Banksia integrifolia* or *Eucalyptus* spp. It has also been collected from rock, rock crevices, concrete paths and shaded limestone. Map 124.

W.A.: Beedelup Falls, *D.H.Norris 25997* (PERTH). S.A.: Waterfall Gully, near Adelaide, *D.G.Catcheside 52.358* (AD). Qld: Bunya Mountains Natl Park, *D.H.Norris 35561* (BRI, HSC). Vic.: Sealers Cove, Jan. 1913, *W.W.Watts s.n*. (HO). Tas.: between Ulverstone and Devonport, *W.A.Weber & D.McVean s.n.* (CANB).

This species is characterised by narrow, elongate gemmae. Goffinet & Vitt (1998: 150) referred it to *Codonoblepharum.*

While this lowland moss is usually restricted to coastal areas (from sea level to an elevation of 70 m), it has been collected at 1000 m in open *Eucalyptus* forest in the Bunya Mtns, south-eastern Qld.

6. Zygodon obtusifolius Hook., *Musci Exot.* 2: 159 (1819)

T: Nepal, *Gardner*; lecto: BM, *fide* J.Lewinsky, *Lindbergia* 15: 21 (1989).

Illustrations: J.Lewinsky, *op. cit.* 111, figs 1–7; 120, figs 35–54 (1989).

Autoicous. Plants ±densely tufted, 5–10 mm tall, olive-green or brownish green above, brown to black below. Stems branched. Rhizoids extending up stem. Leaves appressed and erect when dry, erect-spreading when moist, ligulate or ovate-lanceolate, somewhat keeled, 0.7–1.0 mm long, 0.2–0.3 mm wide; apex obtuse; margin recurved to revolute in lower 50–67% of leaf, crenulate from protruding papillae; costa ending well below apex; base non-decurrent; laminal cells uniform, isodiametric, rounded to irregular, papillose, sometimes a few large linear or rectangular smooth cells near base. Gemmae uniseriate, elongate-clavate, 4–7-celled, 60–120 µm long, 15–25 µm wide, green. Perichaetial leaves undifferentiated. Calyptra often papillose near apex from protruding cell ends. Setae 2–3 mm long. Capsules cylindrical to ovoid, c. 1 mm long, with 8 deep ribs along entire length when dry, red-brown. Peristome double; fragmentary prostome sometimes present; exostome teeth in 8 pairs, reflexed when dry; endostome segments 8 or 16, two-thirds the height of the exostome, lanceolate, white. Spores 12–15 µm diam., finely papillose. Chromosome number not known for Australia. Fig. 30A–I.

Known from only one locality in Tas.; also in New Zealand, Central and South America, Africa and Asia. This species is usually an epiphyte, but it also occurs on rocks. Map 125.

Tas.: Sophia Pt, Macquarie Harbour, *T.B.Moore 26* (HO).

Goffinet & Vitt (1998: 151) treated this species as *Bryomaltea obtusifolia* (Hook.) Goffinet.

AULACOMNIACEAE

Graham H. Bell[1] *& David G. Catcheside*†

Aulacomniaceae Schimp., *Syn. Musc. Eur.* 411 (1860).

Type: *Aulacomnium* Schwägr.

Dioicous or rarely autoicous. Plants small to rather robust in dull green, yellow-green or yellowish brown radiculose tufts, usually tomentose. Stems erect, simple or branched, sometimes terminating in filiform pseudopodia bearing minute leaf-like ecostate gemmae in an apical cluster. Leaves variable, crowded, erect to spreading, unchanged or contorted when dry, lanceolate to oblong-ovate, concave or keeled; margin entire or serrate above, ±revolute, unbordered; costa strong with 2 stereid bands, tapered and flexuose above, ending below apex; upper laminal cells small, isodiametric to elliptical, incrassate, smooth or papillose. Calyptra cucullate, smooth. Setae terminal, ±elongate, erect. Capsules erect to horizontal, symmetrical to asymmetrical, oblong-ovoid to cylindrical, plicate when dry, with 8 longitudinal ribs; apophysis short; annulus broad; operculum bluntly conical to obliquely rostrate; stomata only on apophysis. Peristome double; exostome teeth lanceolate, papillose with numerous lamellae; endostome with a tall basal membrane, keeled, the processes usually perforate; cilia long, slender, nodulose, in groups of 2–4. Spores small.

As defined here, the family is monotypic. *Leptotheca* Schwägr., formerly included in this family, is treated under Rhizogoniaceae following the study of Churchill & Buck (*Brittonia* 34: 1–11, 1982).

AULACOMNIUM

Aulacomnium Schwägr., *Sp. Musc. Frond.*, Suppl. 3, 1: 215 (1827), *nom. cons.*, as *Aulacomnion*; from the Greek *alox* (a furrow) and *mnion* (a moss), in reference to the ribbed capsules of these mosses.

Type: *A. androgynum* (Hedw.) Schwägr., *typ. cons.*

Description as for the family.

Aulacomnium, with up to eight species, is widespread in northern and southern temperate regions and at higher elevations in warmer climates. A worldwide revision should clarify the considerable apparent variability of species across their ranges. Currently, distinctions in the literature between species seem unreliable compared to the variation within species. Unpublished phylogenetic work by O'Brien, cited below, should assist this clarification. One species occurs in Australia.

A.J.E.Smith, Aulacomniaceae, in *Moss Flora of Britain and Ireland* 447–451 (1978); H.A.Crum, *Moss Fl. Mexico* 2: 535–537 (1994); T.J.O'Brien, Phylogeny, species concepts and the evolution of some life history traits in *Aulacomnium* (Bryopsida): evidence from morphology, cpDNA and nrDNA, *Bryologist*, in review (2006) [abstract: http://www.rowan.edu/biology/faculty/obrien/ aulacomnium.htm].

Aulacomnium palustre (Hedw.) Schwägr., *Sp. Musc. Frond.*, Suppl. 3, 1: 216 (1827)

Mnium palustre L. ex Hedw., *Sp. Musc.* 188 (1801). T: near Leipzig, [Germany]; holo?: G.

Illustrations: A.J.E.Smith, *Moss Flora of Britain and Ireland* 450, fig. 218 (1978); H.A.Crum, *Moss Fl. Mexico* 2: 538, fig. 406 (1994).

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[1] State Herbarium of South Australia, Plant Biodiversity Centre, Hackney Road, Hackney, South Australia 5069.

Presumed dioicous. Densely tufted, pale yellowish green, 2.5–6.0 (–10.0) cm tall, densely tomentose with dark brown richly branched rhizoids. Leaves crowded; upper leaves erecto-patent, rather crisped and spirally flexuose when dry; lower leaves sometimes more imbricate and little-changed when dry, oblong to linear-lanceolate, 2–4 mm long, 0.60–0.75 mm wide; apex obtuse and cucullate, or acute and almost erect; margin recurved in lower half or more of leaf, plane above, finely and irregularly denticulate apically; costa somewhat glossy or whitish abaxially when dry; laminal cells small, ±isodiametric to short-rectangular but irregular, 10–15 µm diam., with thick sinuose walls, collenchymatous, slightly longer towards base, a few basal rows (sometimes only near costa) wider, smooth, inflated, yellowish and ±bistratose; all cells, except basal group, with a single spike-like papilla over

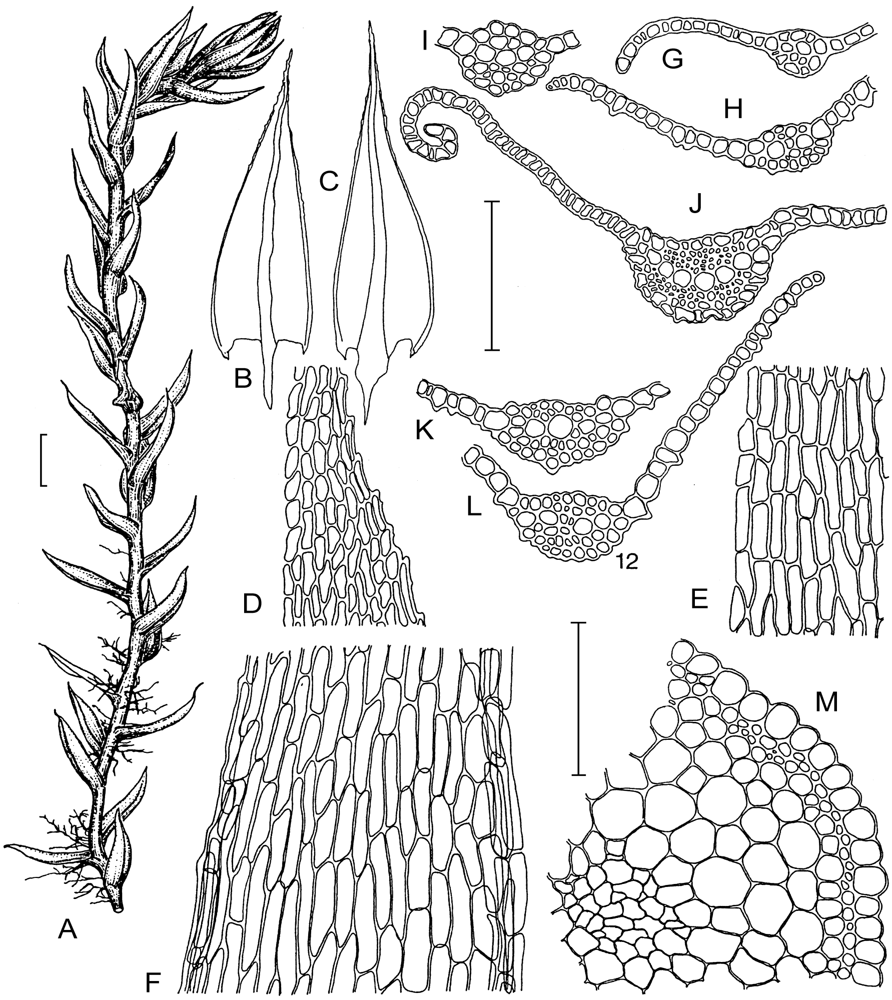

Figure 32. *Aulacomnium palustre*. **A**, Habit; **B**, **C**, Stem leaves; **D**, Cells from upper part of leaf; **E**, Cells from lower mid-lamina; **F**, Mid-laminal cells, from costa to margin; **G–L**, Leaf and costal sections; **M**, Section of part of stem. Scale bars: 1 mm for plant and leaves; 100 µm for cells and sections. Drawn by R.D.Seppelt. Reproduced from *The Moss Flora of Macquarie Island* 61 (2004).

centre of lumen on both surfaces. Axillary hairs c. 50 µm long, with 2 short basal cells and 1 ovate-cylindrical apical cell, all dark-pigmented. Gemmae occasional on terminal pseudopodia, 1.5–5.0 mm long; gemmae soon falling. Sporophyte not seen. Fig. 32.

Grows in scattered, sometimes large colonies in open grassy swamps amid subalpine sclerophyll woodland in N.S.W., A.C.T. and Vic. Also recorded from Macquarie Is. Very widespread and a typical moss of bogs throughout the Northern Hemisphere; apparently much less common in the Southern Hemisphere being reported from eastern Africa, southern South America and New Zealand. Map 126.

N.S.W.: McKeahnies Ck, near Adaminaby, *M.Mueller 160B* (AD, MEL, NSW); near Round Mtn, Snowy Mtns, *D.G.Catcheside 75.3* (AD). A.C.T.: Murrays Gap, Bimberi Ra., *H.Streimann 4424* (AD, CANB). Vic.: Dargo High Plains, Alpine Natl Park, *H.Streimann 53222* (CANB).

Leaf shape and attitude seem to vary considerably between and within populations. Sporophytes have not yet been observed in Australian specimens and, according to foreign literature, are never common. A good description can be found in Crum (1994).

It has not been possible to confirm the record for Tasmania cited by W.Wilson (in J.D.Hooker, *Fl. Tasman.* 2: 192, 1859). There may be a specimen of this Gunn collection from “Formosa” (near Launceston) at BM, but no material of this or any other Tasmanian collection has been located in Australian herbaria. The only recent specimen at HO was misidentified.

BARTRAMIACEAE

Scott R. Gilmore[1]
[*Bartramia* by *Graham H. Bell*]

Bartramiaceae Schwägr., *in* C.L. von Willdenow, *Sp. Pl.* 5(2): 90 (1830).

Type: *Bartramia* Hedw.

Monoicous or dioicous. Plants variable in size, slender to robust, short to tall, ±densely tufted. Stems usually erect and simple, or with subfloral innovations, sometimes sparingly or fastigately branched, ±tomentose below (occasionally densely so). Rhizoids usually ±papillose (smooth in *Conostomum*). Leaves ovate-lanceolate to linear-lanceolate, acute to acuminate; margin entire to serrate; costa failing below apex to long-excurrent; laminal cells linear to rectangular or isodiametric, ±papillose from projecting cell ends, rarely with a central papilla; alar cells present or absent. Calyptra cucullate. Setae well developed, elongate, rarely short and arcuate. Capsules erect to pendulous, globose to short-cylindrical, often furrowed longitudinally when dry; operculum convex to rostrate, with or without an umbo. Peristome single, double or absent. Spores often coarsely papillose or verrucose.

This is a large, cosmopolitan family of 11 genera. Four genera and 24 species are known from Australia. Griffin & Buck (1989) recognised three subfamilies based on axillary hair morphology. Conostomideae is represented in Australia by *Conostomum*, Breutelioideae by *Breutelia* and *Philonotis*, and Bartramioideae by *Bartramia*.

The Bartramiaceae have the common name of Apple Moss due to the shape of the globose, immature capsules. Many species are highly variable, and Sainsbury (*Bull. Roy. Soc. New Zealand* 5: 1–490, 1955) noted that habitat-induced variability could be seen in moist habitats, causing difficulties in the delimitation of species.

G.A.M.Scott & I.G.Stone, *The Mosses of Southern Australia* 322–341 (1976); T.Hiroshama & Z.Iwatsuki, Surface ornamentation of rhizoids of the species of Bartramiaceae (Musci), *J. Hattori Bot. Lab.* 48: 259–275 (1980); D.G.Griffin & W.R.Buck, Taxonomic and phylogenetic studies on the Bartramiaceae, *Bryologist* 92: 268–280 (1989).

KEY TO GENERA

1 Leaves in ranks of 5 (this sometimes obscured when dry); operculum rostrate with a long thin bent apex; peristome teeth absent or smooth and joined at the apex .... **3. CONOSTOMUM**

1: Leaves not ranked; operculum convex to umbonate; peristome teeth absent or papillose and not joined at the apex 2

2 Plants without subfloral innovations; leaves long and narrow (often abruptly narrowed from a sheathing base); apex setaceous *(1:)* .... **1. BARTRAMIA**

2: Plants with subfloral innovations; leaves shorter and more lanceolate (sheathing base not present); apex entire to denticulate, occasionally setaceous 3

3 Leaves usually plicate at least at the base; more than 20 cells between margin and costa at leaf base *(2:)* .... **2. BREUTELIA**

3: Leaves not plicate; fewer than 20 cells between margin and costa at leaf base .... **4. PHILONOTIS**

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1. BARTRAMIA

Graham H. Bell[1]

Bartramia Hedw., *Sp. Musc. Frond.* 164 (1801), *nom. cons.*; apparently named after John Bartram (1699–1777), pioneer American botanist.

Lecto: *B. halleriana* Hedw., *typ. cons.*

Glyphocarpa R.Br., *Trans. Linn. Soc. London* 12: 575 (1819). T: *G. capensis* R.Br.

Monoicous or dioicous. Plants small to very robust, caespitose. Stems simple, sparingly branched near the base, or with rare subfloral innovations, variably tomentose. Rhizoids at least lightly papillose. Leaves not ranked, geniculate or spreading to erect on stems, sometimes curled or twisted when dry, linear-lanceolate or narrowed from an obovate hyaline sheathing base; apex acute; margin plane or revolute, at least the upper parts denticulate; costa strong, percurrent or short-excurrent; laminal cells rectangular, more elongate nearer the leaf base, sometimes with rows of quadrate basal marginal cells, papillose from prorate cell ends. Capsules erect or suberect, globose to ovoid; operculum umbonate. Peristome absent or apparently single, sometimes double with a rudimentary endostome. Spores subglobose or reniform, papillose or verrucose. Chromosome number n = 8 (most species), but also records of n = 6, 12, 16, *fide* H.P.Ramsay, *Austral. J. Bot.* 22: 317–318 (1974).

The taxonomy of *Bartramia* has been in considerable flux for many years, with confusion surrounding several species groups. While there is a need for a worldwide revision of the genus, recent investigations using various morphological characters have begun to clarify the situation. Axillary hair types were found by Griffin & Buck (1989) to be diagnostic at the generic level. Using this character, in conjunction with others, there seems to be a clear grouping of the Australian *Bartramia* species into two groups, although further investigation is required to establish the exact affinities of the second ("Section *Strictidium*") group. Magill (1987) foreshadowed this situation by transferring the South African *B. afrostricta* Müll.Hal. to synonymy under *Anacolia breutelii* (Müll.Hal.) Magill (treated here as *B. breutelii* Müll.Hal.). Further support is found in Fransén (2004b). However, there are difficulties in accommodating the group of related Australian species of *Bartramia s. lat.* within *Anacolia* Schimp. The broader concept of *Bartramia* is retained here pending further investigations. *Bartramia* was subdivided by Brotherus (1909) into 3 sections, and while these were used by Catcheside (1987), they have not been adopted in this treatment. Virtanen (2003) included only four species in his study, an insufficient number to elucidate infrageneric relationships. Fransén (2004a, b) retained the traditional sectional distinctions, with some discussion of their morphological features. *Bartramia* "*stricta*" was widely misapplied in Australia to the taxa segregated by Catcheside (1987) as *B. afrostricta*, *B. nothostricta*, *B. pseudostricta* and *B. strictifolia*.

Bartramia, with approximately 72 species, occurs on soil or, rarely, on rocks in many habitats throughout the world; however, most tropical species are found only at high altitudes (Virtanen, 2000). Nine species are known from Australia; three species and one subspecies are endemic.

V.F.Brotherus, *Bartramia*, *in* A.Engler, *Nat. Pflanzenfam.* I, 3: 635–641 (1909); C.M.Matteri, Synopsis de las especies Andino-Patagonicas, Antarticas y Subantarticas de los generos *Bartramia*, *Bartramidula* y *Conostomum*, *Darwiniana* 25: 143–162 (1984); C.M.Matteri, Bartramiaceae, in *Flora Criptogámica de Tierra del Fuego* XIV, Fasc. 7 (1985); D.G.Catcheside, The genus *Bartramia* (Bartramiaceae) in Australia, *Mem. New York Bot. Gard.* 45: 618–626 (1987); R.E.Magill, Bartramiaceae, in *Flora of Southern Africa: Bryophyta* 1(2): 407–438 (1987); V.Virtanen, Taxonomic studies

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This treatment is based, in part, on research by the late D.G.Catcheside.

of the Bartramiaceae [Bryopsida], *Publ. Bot. Univ. Helsinki* 31 (2000) (http: //thesis/helsinki.fi/julkaisut/mat/ekolo /vk/virtanen/taxonomi.pdf); V.Virtanen, Phylogeny of the Bartramiaceae (Bryopsida) based on morphology and on *rbc*L, *rps*4, and *trn*L-*trn*F sequence data, *Bryologist* 106: 280–296 (2003); R.Fransén, A taxonomic revision of extra-Neotropical *Bartramia* section *Vaginella* C.Müll., *Lindbergia* 29: 73–107 (2004a); R.Fransén, A taxonomic revision of *Bartramia* Hedw. section *Bartramia*, *Lindbergia* 29: 113–122 (2004b).

1 Plants without subfloral innovations; leaf base broadened, hyaline and sheathing; axillary hairs filamentous, to 7 or 8 cells; basal 2–5 cells with pigmented cross-walls only; all basal cells of leaf elongate 2

1: Plants with rare subfloral innovations occurring below some male inflorescences; leaf bases not differentiated; axillary hairs very short, usually comprising 1 pigmented basal cell and 1 hyaline globose cell; leaves with rows of quadrate cells at basal margins 5

2 Lamina cells mostly unistratose; mid-laminal cells mostly isodiametric or broader than long; mature capsules clearly asymmetrical *(1)* .... **4. B. mossmaniana**

2: Laminal cells 2- or 3-stratose; mid-laminal cells elongate; mature capsules symmetrical or nearly so 3

3 Robust plants of alpine bogs; sheathing leaf base obcuneate (1.5 times longer than wide), with the lamina 2- to 3-stratose near shoulder; green lamina triangular, 3- or more stratose; spores reniform, finely and densely papillose *(2:)* .... **9. B. subsymmetrica**

3: Slender to small plants of drier habitats; sheathing leaf base oblong (3 times longer than wide), with the lamina unistratose; green lamina linear-lanceolate, 2-stratose; spores ±globose, verrucose 4

4 Plants usually > 1 cm tall; leaves usually spreading; peristome present (although often lost); exothecial cells without prominent trigones *(3:)* .... **7. B. robusta**

4: Plants < 0.8 cm tall; leaves suberect; peristome absent; exothecial cells with prominent trigones .... **3. B. hampeana** subsp. **hampei**

5 Leaves 3.5–4.5 mm long, with 9–12 longitudinal rows of quadrate cells at basal margin *(1:)* 6

5: Leaves 1.5–3.5 mm long, with up to 5 rows of quadrate cells at basal margin 7

6 Lamina with numerous projecting spinose papillae; margin narrowly revolute to near apex *(5)* .... **1. B. alaris**

6: Laminal papillae low and ‘mounded’, not spinose; margin revolute in lower half or less .... **2. B. breutelii**

7 Leaves spreading, flexuose; spores 24–28 µm diam., with small dense verrucae *(5:)* .... **6. B. pseudostricta**

7: Leaves erect and appressed to stem when dry; spores 24–35 µm diam., with fewer larger verrucae 8

8 Spores 24–25 µm diam., with a few large domed verrucae; leaves usually with 16–22 cells between costa and margin (at the base), 2–5 rows at the margin being quadrate *(7:)* .... **8. B. strictifolia**

8: Spores 30–35 µm diam., with very large irregular verrucae; leaves usually with 15–17 cells between costa and margin (at the base), 1–2 (–3) rows at margin being quadrate .... **5. B. nothostricta**

1. Bartramia alaris Dixon & Sainsbury, *J. Bot.* 71: 244 (1933)

T: near Havelock North, Hawkes Bay, New Zealand, Jan. 1929, *E.A.Hodgson* [Herb. G.O.K.Sainsbury 563]; holo: BM? *n.v.*; iso: AK?, WELT? *n.v.*

Plants moderately robust, to c. 14 mm tall, caespitose, glaucous green above with yellowish tips, dull brownish green below. Stems with a strong central strand, lacking a hyalodermis. Rhizoids basal only, papillose, reddish brown. Leaves erect, closely appressed but often curled or twisted apically when dry, linear-lanceolate, 4.4–5.0 mm long, 0.75–0.80 mm wide; margin narrowly revolute almost to apex; upper margin strongly denticulate (multiple rows), with enlarged cells; costa strong, glossy and prominent abaxially, with a strong abaxial stereid band and a weaker adaxial band; axillary hairs minute, apparently consisting of a single hyaline cell; upper lamina bistratose; cells very obscure, c. 12.5 × 7.5 µm, spinose-papillose from enlarged prorate cell ends; lower lamina patchily bistratose, with cells elongate, to 55 × 10 µm, and with c. 10 rows of shorter quadrate cells at alar margin. Sporophytes not seen in Australian material, probably also unknown in New Zealand.

Known only from several collections made by W.W.Watts in 1899 from one locality in eastern N.S.W.; rare in New Zealand. The Australian specimens were recorded from soil on a river bank, growing with *Triquetrella*, as also noted in New Zealand. Map 127.

N.S.W.: bank of Nepean R., *W.W.Watts 3203* (AD, NSW).

This species may be more widespread, but further investigation is needed as there seem to be few other collections of Bartramia from this area of N.S.W. *Bartramia alaris* is most similar to *B. breutelii*, differing mainly in the leaf margins and the presence of spinose laminal papillae.

2. **Bartramia breutelii** Müll.Hal., *Bot. Zeitung (Berlin)* 16: 162 (1858)

Anacolia breutelii (Müll.Hal.) Magill, *Fl. Southern Africa: Bryophyta* 1(2): 411 (1987). T: Soutkloof, Cape Province, South Africa, *Breutel s.n.*; syn?: BM, G *n.v.*

Bartramia afrostricta Müll.Hal., *Hedwigia* 38: 94 (1899). T: Cape Town, South Africa, *Rehmann 203, 204*; syn: BM, PRE *n.v.*

Illustrations: D.G.Catcheside, *Mosses of South Australia* 283, fig. 169, pl. 11B (1980), as *Bartramia* sp. A; R.E.Magill, *loc. cit.* fig. 116 (14–27), as *Anacolia breutelii*.

Dioicous (in South Africa). Plants moderately robust, 1.0–2.5 (–4.0) cm tall, loosely caespitose, yellow-green above, dull brownish green below. Stems with a central strand, lacking a hyalodermis. Rhizoids sparse, basal only, weakly papillose, very dark reddish brown. Leaves erect, usually closely appressed when dry, linear-lanceolate, 3.0–4.5 mm long and 0.6–0.9 mm wide; lower margin revolute; upper margin denticulate (single or double teeth), with enlarged cells; costa strong, prominent abaxially, with a strong abaxial stereid band and a weaker adaxial band; axillary hairs c. 17.5 µm long, usually of 2 cells, the upper globose, the lower pigmented; upper lamina bistratose, with cells 17.5–37.5 × 7.5–10.0 µm, strongly papillose with low 'mounded' papillae (formed from the combined prorate ends of adjacent cells); lower lamina patchily bistratose, with elongate cells to c. 50 × 15 µm, with 10–12 rows of shorter quadrate cells at the alar margin. Sporophytes not seen in Australian material and said to be rare in South Africa.

Occurs in W.A., S.A., N.S.W. and Vic., on small soil pockets over rock in sheltered gorges, sometimes in otherwise dry areas. Also in South Africa. Map 128.

W.A.: Swan River, *J.Drummond 31* (BM). S.A.: River Torrens Gorge, 15 km NE of Adelaide, *N.N.Donner 3442* (AD). N.S.W.: "Braehour", 11 km E of Wagga Wagga, *H.Streimann 2066* (CANB). Vic.: Hughes Ck, 13 km ENE of Seymour, *H.Streimann 2353* (CANB).

This is one of several confused taxa related to "*Bartramia stricta*" under which name most Australian specimens were once classified. Catcheside (1987) discussed the relationships, and Magill (1987) transferred *B. afrostricta* to synonymy under *Anacolia breutelii*. However, due to difficulties accommodating a group of closely related Australian *Bartramia* species within *Anacolia*, the broader concept of *Bartramia* is retained here pending further investigation.

3. **Bartramia hampeana** Müll.Hal., *Bot. Zeitung (Berlin)* 16: 162 (1858)

subsp. **hampei** (Mitt.) Fransén, *Lindbergia* 29: 90 (2004)

Bartramidula hampei Mitt., *Trans. & Proc. Roy. Soc. Victoria* 19: 68 (1882); *Bartramia hampei* (Mitt.) Catches., Mosses of South Australia 281 (1980). T: Mt William, Grampians, Vic., *D.Sullivan s.n.*; holo: BM; iso: MEL? n.v.

Glyphocarpa erecta Hampe, *Linnaea* 40: 305 (1876); *Bartramia erecta* (Hampe) Broth., *Nat. Pflanzenfam.* I, 3: 637 (1904), *nom. illeg. non* Mitten (1869). T: Mt William, Grampians, Vic., *D.Sullivan s.n.*; holo: BM; iso: MEL? *n.v.*

Bartramia gymnostoma Broth. ex Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 151 (1906), *nom. nud.* Based on: Koorawatha, N.S.W., *W.W.Watts 7308* (NSW), *fide* annotations by Brotherus on specimen packet.

?*Bartramia papillata* Hook.f. & Wilson var. *brevifolia* Broth. & Geh., *nom. nud.* [Watts & Whitelegge, *Proc. Linn. Soc. New South Wales*, 30 (Suppl.): 152 (1906)]. Based on: summit of Mt Koscius[z]ko, N.S.W., *D.Sullivan* (MEL?).

Illustrations: D.G.Catcheside, *loc. cit.*, fig. 167, pl. 11A, as *B. hampei*; S.Fransén, *op. cit.* 91, fig. 9.

Dioicous. Plants small, to 8 mm tall, loosely caespitose, dull brownish or yellow-green. Stems with a weak central strand and a weakly differentiated hyalodermis. Rhizoids moderately dense at base, weakly papillose, reddish brown. Leaves suberect, with an oblong to obovate hyaline sheathing base and a linear-lanceolate green upper lamina, to 2.0–5.5 mm long, 0.375–0.500 mm wide; margin plane, upper margin denticulate (single or double teeth); costa strong, not prominent abaxially, with a strong abaxial stereid band and no adaxial band; axillary hairs to c. 225 µm long, usually with 2 short basal cells with pigmented cross-walls and 1–5 elongate hyaline cells; upper lamina bistratose, with cells 25–50 × 7.5–10.0 µm, strongly papillose with high ‘twinned’ papillae (formed from the combined prorate ends of adjacent cells); lower lamina unistratose, lacking shorter quadrate cells at the alar margin, with cells elongate, to c. 200 × 17.5 µm. Setae 5–10 mm long. Capsules suberect to inclined, subglobose, c. 1.5 mm long and 1 mm wide, sulcate when dry; exothecial cells usually hexagonal, with prominent trigones c. 30 × 20 µm. Peristome absent or, occasionally, a short membrane. Spores subglobose, 50–55 µm diam., reddish brown, densely verrucose.

Endemic to Australia, occurring in W.A., S.A., N.S.W., ACT, Vic. and Tas. Moderately common in dry, lowland or montane habitats. Map 129.

W.A.: foot of Bluff Knoll, Stirling Ra., *D.G.Catcheside 74.292* (AD). S.A.: Yanagin Rd, near Greenhill, *D.G.Catcheside 80.35* (AD). N.S.W.: 3 miles [c. 4.9 km] S of Jenolan Caves, *J.M.Glime 7928* (AD, CANB). A.C.T.: Australian National Botanic Gardens, Canberra, *H.Streimann 2550* (CANB). Vic.: Mirranatawa Gap, Grampians, *D.G.Catcheside 77.211* (AD). Tas.: Ridgeway Park, *A.V.Ratkowsky H610* (HO).

This is sometimes difficult to distinguish from *B. robusta*, but it is usually smaller, often glaucous and has an oblong leaf base that is neither geniculate nor as broadened at the shoulders as in *B. robusta*. Moreover, the latter has a peristome, although immature capsules must be examined as the peristome of *B. robusta* seems to be fragile and soon lost.

Bartramia hampeana subsp. *hampeana* is endemic to South Africa.

4. **Bartramia mossmaniana** Müll.Hal., *Bot. Zeitung (Berlin)* 9: 552 (1851)

T: Mount Wellington, Tas., Apr. 1850, *S.Mossman 751*; holo: B? *n.v.*

Bartramia halleriana sensu Matteri, *Darwiniana* 25: 152 (1984).

Bartramia halleriana var. *brachydonta* Kabiersch, *Hedwigia* 77: 83 (1937). T: Canterbury, South Island, New Zealand, 1883, *Cheeseman 153*; syn; Castle Hill Distr. [Canterbury], New Zealand, Apr. 1895, “H? ex Herb. Cockayne, Musci n. 12”; syn; “Oberer Broken River”, 3 Feb. 1902, *L.Diels 6309*; syn; Mt Wellington, Tas., Apr. 1850, *S.Mossman 751*; syn; [Tas.], Dec. 1888, *W.A.Weymouth 102*; syn; Huon Rd, Tas., Feb. 1878, *O.Beccari*; syn; Patagonia, [Argentina], 1896, *P.Dusén*; syn; Punta Arenas, [Argentina], Nov. 1895, *P.Dusén*; syn; Burnst Island, [Argentina], May 1892, *Spegazzini*; syn.

[*Bartramia norvegica auct. non* Lindb.: L.Rodway, *Tas. Bryoph.* 1: 92 (1914)]

Illustrations: D.G.Catcheside, *Mem. New York Bot. Gard.* 45: 625, fig. 4c–f (1987); G.A.M.Scott & I.G.Stone, *The Mosses of Southern Australia* 325, pl. 61 (1976).

Autoicous or synoicous. Plants large, 3–10 cm tall, loosely caespitose, yellow-green. Stems with a small central strand, lacking a hyalodermis. Rhizoids dense at base, forming a somewhat matted turf, strongly papillose, pale reddish brown. Leaves geniculate, patent and loosely crisped when dry, with an obovate hyaline sheathing base and a linear-lanceolate green upper lamina, to 11.75 mm long and 1.125 mm wide; upper margin recurved, denticulate (single or double teeth) by means of differentiated enlarged cells; costa strong, ±prominent abaxially, with a strong abaxial stereid band and no adaxial band; axillary hairs to c. 200 µm long, with 4 or 5 basal cells with pigmented cross-walls and 2 or 3 hyaline apical cells; upper lamina unistratose except for bistratose recurved margin, with cells to 20 × 10 µm, mostly ±quadrate, papillose from prorate cell ends; lower lamina unistratose, lacking shorter quadrate cells at the alar margin, with cells elongate, to c. 75 × 15 µm. Setae 2–8 mm long. Capsules asymmetrical, suberect, subglobose to broadly cylindrical, c. 1.5 × 1.0 mm, curved and sulcate when dry; exothecial cells irregular, quadrate to hexagonal, evenly thickened (without trigones). Peristome of red-brown exostome teeth and with a rudimentary endostome. Spores subglobose, 25–30 µm diam., reddish brown, coarsely papillose. Plate 28.

Rare in N.S.W. and Vic., but widespread in Tas. Occurs mainly in montane to subalpine habitats, sometimes in rainforest. Also recorded from southern Chile, Argentina, New Zealand and New Guinea. Map 130.

N.S.W.: Yarrangobilly Caves, Reservoir Gully, *W.W.Watts 8693* (NSW). Vic.: by road from Chalet to L. Catani, Mt Buffalo, *D.G.Catcheside 74.13* (AD). Tas.: Platform Peak, *A.Moscal 7891* (HO).

The use of the epithet *mossmaniana* for this taxon (cf. Matteri, *loc. cit.*, 1984, as a synonym of *B. halleriana*) follows the usage of Catcheside (1987). Fransén (2004b) supported the separation of these two taxa, restricting *B. halleriana* to the Northern Hemisphere, and re-defining *B. mossmaniana* with a broader Southern Hemisphere distribution.

5. **Bartramia nothostricta** Catches., *Mem. New York Bot. Gard.* 45: 621 (1987)

T: Waterfall Gully, S.A., 16 Nov. 1952, *D.G.Catcheside 52.344*; holo: AD.

[*Bartramia stricta auct. non* Brid.: D.G.Catcheside, *Mosses of South Australia* 282 (1980)]

Illustrations: D.G.Catcheside, *loc. cit.* fig. 168 (1980), as *B. stricta*; D.G.Catcheside, *op. cit.* 619, fig. 1e, f (1987).

Synoicous. Plants short, 5–10 mm tall, densely caespitose, bright green above, brownish below. Stems with a comparatively large central strand, lacking a hyalodermis. Rhizoids sparse, at base only, slightly papillose, dark red-brown. Leaves erect, closely appressed when dry, narrowly lanceolate, without a sheathing base, 1.5–4.0 mm long, c. 0.5 mm wide; margin narrowly recurved, denticulate (single or double teeth) by means of differentiated enlarged cells, bistratose; costa strong, ±prominent abaxially, with a small abaxial stereid band and a smaller adaxial band; axillary hairs c. 25 µm long, with 2 short basal cells with pigmented cross-walls and 1 larger globose hyaline cell; lamina mainly unistratose with occasional bistratose patches, with upper cells to 45 × 10 µm, papillose from prorate cell ends; lower lamina unistratose, with cells hyaline, smooth, elongate, to 75 × 12.5 µm, with 3–5 weakly defined rows of shorter quadrate cells at the alar margin. Setae c. 8 mm long. Capsules erect, subglobose to ovoid, c. 0.8–1.3 mm long and 0.6–0.8 mm wide, shallowly sulcate when dry; exothecial cells polygonal, isodiametric, with trigones. Peristome of short yellowish exostome teeth, with or without a rudimentary endostome. Spores subglobose, 30–35 µm diam., pale reddish brown, coarsely and irregularly verrucose.

Endemic to S.A. and Vic., either rare or undercollected, on soil of banks in sclerophyll forest and beside streams, usually in small colonies. Map 131.

S.A.: Alligator Gorge, Flinders Ra., *D.G.Catcheside 83.13* (AD); Waterfall Gully, *R.D.Seppelt 0117* (HO). Vic.: Mt Tarrengower, *I.G.Stone 14569* (AD, MEL).

6. **Bartramia pseudostricta** Catches., *Mem. New York Bot. Gard.* 45: 621 (1987)

T: Upper Alligator Gorge, Flinders Ra., S.A., 23 Aug. 1953, *D.G.Catcheside 53.200*; holo: AD.

Bartramia compacta sensu Stoneburner *et al.*, *Bryologist* 96: 94 (1993); *B.* cf. *compacta sensu* Scott & Stone, *The Mosses of Southern Australia* 328 (1976)

Illustration: D.G.Catcheside, *Mosses of South Australia* 285, fig. 170 (1980), as *Bartramia* sp. B.

Synoicous. Plants short, 5–10 mm tall, loosely caespitose, glaucous green above, brownish below. Stems with a well-defined central strand, lacking a hyalodermis. Rhizoids at base only, slightly papillose, dark red-brown. Leaves spreading and flexuose wet or dry, linear-lanceolate, without a sheathing base, to 3.25 mm long, 0.500–0.625 mm wide; margin narrowly recurved, denticulate (single or double teeth) by means of differentiated enlarged cells, unistratose; costa strong, ±prominent abaxially, with strong abaxial and adaxial stereid bands; axillary hairs c. 15 µm long, with 1 short pigmented basal cell and 1 larger globose hyaline cell; lamina mainly unistratose with occasional bistratose patches, with upper cells 30–50 × 7–10 µm, papillose almost to base from prorate cell ends; lower lamina unistratose, with cells elongate, to 75 × 15 µm, with 2–5 weakly defined rows of shorter quadrate cells at alar margin. Setae erect to flexuose, to c. 15 mm long. Capsules erect, ovoid to globose, to c. 1.5 mm long, shallowly sulcate when dry; exothecial cells polygonal, isodiametric, with trigones. Peristome of narrow yellowish orange exostome teeth and a short membranous

endostome bearing thin filaments. Spores subglobose, 24–28 µm diam., dark brown, with small dense verrucae.

Endemic to W.A. and S.A. and either rare or undercollected; grows in small patches on soil of stream banks and by tracks in sclerophyll scrub. Map 132.

W.A.: Mt Cooke, Darling Ra., *R.Wyatt & A.Stoneburner 3900* (AD, PERTH); Serpentine Falls, *I.G.Stone 4782* (AD, MEL). S.A.: Melrose, foot of Mt Remarkable, *D.G.Catcheside 53.173* (AD).

7. **Bartramia robusta** Hook.f. & Wilson, *Fl. Antarct.* 1: 133, t. 59, fig. 4 (1844)

T: Lord Auckland's group [Auckland Is.], 1839–43, *J.D.Hooker*; lecto: BM *n.v.*, *fide* S.Fransén, *op. cit.* 200 (2004a).

Bartramia ithyphylla sensu Matteri, *Darwiniana* 25: 150 (1984).

Bartramia papillata Hook.f. & Wilson, *in* J.D.Hooker, *Fl. Nov.-Zel.* 2: 89, t. 86, fig. 4 ('1855') [1854]. T: Bay of Islands, New Zealand, 1839–43, *J.D.Hooker*; lecto: BM *n.v.*, *fide* C.M.Matteri, *Darwiniana* 25: 150 (1984).

Bartramia acerosa Müll.Hal. & Hampe, *Linnaea* 28: 208 (1856). T: Snowy R., Vic., 1854, *F.Mueller*; holo?: BM-Hampe *n.v.*; iso?: MEL *n.v.*, *fide* H.P.Ramsay, *Register of Type Specimens of Mosses in Australian Herbaria* 12 (1994)

Bartramia fragilis Mitt. ex Wilson, *in* J.D.Hooker, *Fl. Tasman.* 2: 196 (1859). T: rivulet behind Cummings Head, Western Mountains, Tas., *Archer s.n.*; holo: BM? *n.v.*

Bartramia acerosa Müll.Hal. & Hampe var. *minor* Hampe ex Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 152 (1906), *nom. nud*.

Illustration: D.G.Catcheside, *op. cit.* 280, fig. 166, as *B. papillata*.

Dioicous. Plants medium-sized, to 3 cm tall, loosely caespitose, yellow-green. Stems with a central strand and a hyalodermis. Rhizoids dense at base, sometimes ascending the stem, papillose, reddish brown. Leaves geniculate, with an obcuneate hyaline sheathing base and a linear-lanceolate green upper lamina, to 3.50–6.25 mm long, 0.5–1.0 mm wide; upper margin plane, denticulate (single or double teeth) by means of differentiated enlarged cells; costa strong, ±prominent abaxially, with a strong abaxial stereid band and no adaxial band; axillary hairs to c. 75 µm long, usually with 2 short basal cells with pigmented cross-walls and 1 or 2 elongate hyaline cells; upper lamina bistratose, with cells c. 37.5 × 7.5 µm, papillose with mostly low 'mounded' papillae (formed from the combined prorate ends of adjacent cells); lower lamina unistratose, lacking shorter quadrate cells at the alar margin, with cells elongate, to c. 190 × 30 µm. Setae 10–30 mm long. Capsules suberect, subglobose, c. 2 mm long and 1 mm wide, sulcate when dry; exothecial cells short-rectangular, ±evenly thickened, c. 60 × 25 µm. Peristome of orange exostome teeth and with a rudimentary endostome. Spores subglobose to reniform, to c. 35 × 50 µm, brown, coarsely and densely verrucose. Plates 26, 27.

Known from W.A., S.A., Qld, N.S.W., A.C.T., Vic. and Tas.; grows on soil in open herbfield or on and among rocks in moist valleys, often near streams. Mostly in montane to alpine areas to c. 1500 m altitude. Widespread throughout Eurasia, India to SE Asia, North Africa, North America, southern South America, New Zealand and Subantarctic islands (including Macquarie Is. and Heard Is.). Map 133.

W.A.: track to Toolbrunup Peak, Stirling Range Natl Park, *H.Streimann 54512* (CANB). S.A.: Bridgewater, 25 Sept. 1954, *E.M.Wollaston* (AD). Qld: South Bald Rock, Darling Downs, *I.G.Stone 13514,* (BRI, MEL). N.S.W.: Round Mtn, Mount Kosciuszko Natl Park, *H.Streimann 35127* (CANB, HO). A.C.T.: Kambah Pool, by Murrumbidgee R., *D.G.Catcheside 64.88* (AD, CANB). Vic.: Victoria Ra., Grampians, *H.Streimann 2927* (AD, CANB). Tas.: Mt Rufus, *A.Moscal 14390* (HO).

This is by far the most common and variable *Bartramia* in Australia. Similar to *B. hampeana* subsp. *hampei*, but usually larger, greener and with an obcuneate leaf base, broadened at the shoulders and usually strongly geniculate, resulting in the green upper lamina being patent, and often clearly demarcated from the hyaline sheathing base.

Traditionally called *B. papillata* in Australia, that species was placed in synonymy under *B. ithyphylla* by Matteri (1984). Fransén (2004a) reassessed the group of species including *B. ithyphylla*, and treated the geographically isolated South American material as *B. ithyphylla* subsp. *patens*, restricting *B. ithyphylla* subsp. *ithyphylla* to high latitudes of the Northern

Hemisphere. Chromosome number appears to support Fransén's concept here, as Ramsay (*in* A.Löve, *Taxon* 16: 556, 1967) indicated n = 8 for Australian material (*B. robusta*, as *B. papillata*), whereas Fransén quoted reports of n = 12 in *B. ithyphylla* subsp. *ithyphylla* and n = 16 in *B. ithyphylla* subsp. *patens*,.

8. **Bartramia strictifolia** Taylor, *London J. Bot.* 5: 54 (1846)

T: Swan River, W.A., *J.Drummond 31 p.p.*; holo: BM *n.v.*

Bartramia strictifolia Taylor var. *minor* Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 152 (1906), *nom. nud*. Based on: Kangaroo Point, [Bellerive], Tas., 2 Sept. 1889, *W.A.Weymouth s.n.* (HO 43399).

Illustration: D.G.Catcheside, *Mem. New York Bot. Gard.* 45: 619, fig. 1c, d (1987).

Synoicous. Plants small, less than 10 mm tall, loosely caespitose, usually pale yellowish green above, brown below. Stems with a small central strand, lacking a hyalodermis. Rhizoids at base only, slightly papillose, dark red-brown. Leaves closely appressed and sometimes slightly twisted around stem when dry, narrowly lanceolate, without a sheathing base, 2.75–3.50 mm long, 0.625–0.750 µm wide; margin narrowly recurved, bistratose, denticulate (single or double teeth) by means of differentiated enlarged cells; costa strong, ±prominent abaxially, with strong abaxial and adaxial stereid bands; axillary hairs minute, c. 20 µm long, with 1 short pigmented basal cell and 1 larger globose hyaline cell; upper lamina variably bistratose, with cells c. 55 × 10 µm, papillose almost to the base from prorate cell ends; base of lamina unistratose, with inner cells elongate, to 62.5 × 15 µm, with 2–6 rows of shorter quadrate cells at alar margin. Setae erect to flexuose, to c. 15 mm long. Capsules globose, erect, c. 1 mm long, shallowly sulcate when dry; exothecial cells ±hexagonal, evenly thickened (without trigones). Peristome of short dull orange exostome teeth and a short membranous endostome bearing thin filaments. Spores subglobose, 24–25 µm diam., with a few large domed verrucae.

Endemic to W.A. and Tas., currently recognised from only a few sites, from the Darling Ranges near Perth, W.A. and the coast and islands of south-eastern Tas. Map 134.

W.A.: Helena R., Darling Ra., 27 July 1914, *coll. unknown* (AD, UWA); Gooseberry Hill, Darling Ra., 15 Aug. 1914, *coll. unknown* (NSW, UWA). Tas.: Kangaroo Point, [Bellerive], 2 Sept. 1889, *W.A.Weymouth* (HO); Maria Is., *L.Rodway 181* (HO).

The original description of Taylor (1846) reported "stems an inch high" which seems to be either confused or erroneous, since no material seen reaches this height, even including the sporophyte.

9. **Bartramia subsymmetrica** Cardot, *Bull. Herb. Boissier*, sér. 2, 6: 8 (1906)

T: Cumberland Bay, Jason Harbour, South Georgia, *C.Skottsberg 328*; lecto: BA; isolecto: S, *n.v.* [see Matteri (1984)]

Bartramia bogongia Catches., *Mem. New York Bot. Gard.* 45: 621 (1987). T: Mt Nelse Track, Rocky Valley Reservoir, Bogong High Plains, Vic., 25 Feb. 1986, *G.A.M.Scott & B.A.Fuhrer s.n.*; holo: MUCV 7155 *n.v.*; iso: AD, MEL *n.v.*

Illustrations: D.G.Catcheside, *op. cit.* 622, fig. 2; 624, fig. 3h–k.

Plants very robust, to 10 cm tall, densely caespitose in large cushions, usually golden-yellow throughout, sometimes duller brownish towards the base. Stems with a weak central strand, lacking a hyalodermis. Rhizoids moderately dense, variably papillose, reddish brown, basal and at intervals along stem. Leaves suberect, with an obcuneate hyaline sheathing base and triangular green upper lamina, to 5.25 mm long and 1.5 mm wide; margin plane, upper margin denticulate (single or double teeth) due to prorate cell ends; costa strong, not prominent abaxially, with a strong abaxial stereid band and no adaxial band; axillary hairs to c. 300 µm long, with 1–4 pigmented basal cells and 2–4 elongate hyaline cells; upper lamina mostly tristratose, with cells to 50 × 10 (–20) µm, strongly papillose, with low mounded papillae (formed from the combined prorate ends of adjacent cells); lower lamina unistratose, with cells elongate, to c. 160 × 10 µm, without rows of shorter quadrate cells at the alar margin. Setae c. 2.5 cm long. Capsules suberect, ±globose, c. 2 mm long and 1.5 mm wide, smooth when dry; exothecial cells uniformly thickened, 10–20 µm diam. Peristome

apparently single, of short pale fragile segments. Spores brown, reniform, c. 35 × 30 µm, finely and densely papillose.

Restricted to the alpine areas of N.S.W. and Vic.; grows in boggy sites and beside streams. Also in Argentina and South Georgia. Map 135.

N.S.W.: near Rawson Pass, Mount Kosciuszko Natl Park, *D.G.Catcheside 68.77* (AD); Guthries Ck, Mount Kosciuszko Natl Park, *I.G.Stone 10329* (AD, MEL). Vic.: Mt Hotham, *D.G.Catcheside 69.196* (AD, MEL).

One of the largest species of *Bartramia* in Australia, the size, colour and leaf morphology are sufficient to distinguish it from other taxa. *Bartramia mossmaniana* has a unistratose upper lamina and much longer leaves with a more open appearance and usually a green rather than golden colour, while *B. robusta* and *B. hampeana* subsp. *hampei* are generally smaller and less robust. Previously believed to be endemic, *B. bogongia* has recently been placed in synonymy by Fransén (2004a).

2. BREUTELIA

Scott R. Gilmore[1]

Breutelia (Bruch & Schimp.) Schimp., *Coroll. Bryol. Eur.* 85 (1856); named after Johann Christian Breutel (1788–1875), a German bryologist.

Type: *B. arcuta* (Sw.) Schimp.

Bartramia sect. *Breutelia* Bruch & Schimp., *in* Bruch, Schimper & von Gumbel, *Bryol. Eur.* 4: 1 (1851); *Bartramia* subg. *Breutelia* (Bruch & Schimp.) Hampe, *Ann. Sci. Nat. Bot.*, sér. 5, 3: 373 (1865).

Dioicous. Plants medium-sized to large, ±densely tufted, yellow, yellowish green, glaucous green, or bright green to blackish. Stems simple, sparingly branched or with subfloral innovations (most commonly branched near apex), red to reddish purple, tomentose in lower half. Rhizoids papillose, red-brown. Leaves unranked, imbricate, erect to squarrose, more spreading when moist, ovate-lanceolate, oblong-lanceolate to narrowly lanceolate, acuminate; margin plane or recurved, denticulate to serrate; costa strong, percurrent to long-excurrent; laminal cells ±regular, isodiametric to linear, with a single papilla overtopping cells; basal cells usually longer, subquadrate to rectangular; basal marginal cells ±inflated. Capsules inclined to horizontal (rarely almost erect), cylindrical when dry, ovoid when moist; operculum convex, with or without an umbo. Peristome double; exostome teeth 16, finely papillose; endostome papillose; membrane c. one-third the height of the exostome; endostome processes slightly shorter than and alternating with exostome teeth. Spores globose, ovoid or reniform, verrucose.

This genus of approximately 125 species is especially diverse in temperate regions of the Southern Hemisphere. Traditionally only three rather variable species were recognised in Australia; however, two additional taxa are documented here.

Characteristically a cross-section of the stem of *Breutelia* shows a denticulate margin. This, along with the plication of the leaves, distinguishes it from other genera of the Bartramiaceae. Each year's new growth is often a paler colour and quite distinct from older growth.

V.Virtanen, Bryophyte flora of the Huon Peninsula, Papua New Guinea LIX. *Breutelia* (Bartramiaceae, Musci), *Acta Bot. Fenn.* 156: 49–62 (1996).

1 Leaves plicate only at the base (occasionally not plicate); alar cells not inflated; costa long-excurrent 2

1: Leaves plicate throughout; alar cells inflated; costa percurrent to short-excurrent 4

  2 Leaves narrowly lanceolate; mid-leaf laminal cells elongate, thick-walled, porose *(2)* .... **4. B. pseudophilonotis**

  2: Leaves ovate-lanceolate to lanceolate; mid-leaf laminal cells thin-walled, not (or rarely) porose 3

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3 Leaves ovate-lanceolate to oblong-lanceolate; subquadrate basal cells numerous, usually extending to one-third the height of the lamina; mid-leaf laminal cells irregular, isodiametric, short-rectangular to linear *(2:)* .... **1. B. affinis**

3: Leaves lanceolate; subquadrate basal cells reduced (rarely absent), extending to one-fifth the height of the lamina; mid-leaf laminal cells short-rectangular .... **5. Breutelia** sp. **A**

4 Mid-leaf laminal cells regular, linear, porose, thick-walled; costa to 40 µm wide at the base *(1:)* .... **2. B. elongata**

4: Mid-leaf laminal cells irregular, isodiametric to linear, ±porose, not as thick-walled; costa usually more than 40 µm wide at the base .... **3. B. pendula**

1. **Breutelia affinis** (Hook.) Mitt., *Hooker's J. Bot. Kew Gard. Misc.* 8: 261 (1856)

Bartramis affinis Hook., *Musci Exot.* 2: 16 (1820); *Glyphocarpus affinis* (Hook.) A.Jaeger, *Ber. Tätigk. St. Gallischen Naturwiss. Ges.* 1873–74: 63 (1875); *Philonotis affinis* (Hook.) A.Jaeger, *Ber. Tätigk. St. Gallischen Naturwiss. Ges.* 1877–78: 505 (1879). T: Insula Van Diemen, [Tas.], *R.Brown*; BM? *n.v.*

Bartramia commutata Hampe, *Linnaea* 40: 307 (1876), *nom. illeg.*; *Breutelia commutata* A.Jaeger, *Ber. Tätigk. St. Gallischen Naturwiss. Ges.* 1877–78: 438 (1879). T: Grampians, Vic., *W.Sullivan*, syn: BM? *n.v.*, *fide* H.N.Dixon, *Bull. New Zealand Inst.* 3: 231 (1926).

Illustrations: D.G.Catcheside, *Mosses of South Australia* 287, fig. 172 (1980); D.Meagher & B.Fuhrer, *Field Guide to the Mosses and Allied Plants of Southern Australia* 131 (2003).

Stems to c. 7 cm long, dense, commonly branching towards the apices. Leaves imbricate, erect to erect-spreading when dry, ovate-lanceolate or oblong-lanceolate, tapering to an acuminate apex, plicate at base, 1.7–3.8 mm long, 0.4–0.9 mm wide; margin recurved in lower part of leaf, plane and denticulate above; costa long-excurrent, less commonly short-excurrent; mid-leaf laminal cells irregular in shape and size, isodiametric to short-rectangular and linear, with rounded ends, 6–40 × 2–6 µm, thin-walled (wall c. 2 µm), rarely porose, with a large patch (including many rows) of smooth subquadrate alar cells extending to c. one-third of the leaf lamina; alar cells c. 10 µm wide. Setae c. 25 mm long. Capsules cylindrical and sulcate when dry, inclined or horizontal, rarely pendulous. Spores 24–32 (–36) µm diam. $n = 6$, *fide* H.P.Ramsay, *Austral. J. Bot.* 22: 318 (1974).

Occurs in W.A., S.A., Qld, N.S.W., A.C.T., Vic. and Tas.; also in New Zealand. This common species is found on rocks and soil in permanently or occasionally moist conditions. It can form very large mats covering rock faces. Map 136.

W.A.: track to Hayward Peak, *H.Streimann 54476* (CANB). S.A.: Hindmarsh Falls, *H.Streimann 54805* (CANB). Qld: Blencoe Ck, Cardwell Ra., *H.Streimann 37795* (CANB). N.S.W.: Parlour Ck, *S.R.Gilmore 62* (CANB). A.C.T.: Molonglo Gorge, *P.J.Darbyshire 488* (CANB). Vic.: Lookout Hill, Mount Cole State Forest, *H.Streimann 55442* (CANB). Tas.: SW of Great Western Tiers, *J.A.Curnow 2259* (CANB).

This moss is rather variable in its habit, and adjacent plants can look quite different in their leaf arrangement, the amount of stem tomentum, leaf shape and size, and the papillosity of the cells. The large number of subquadrate basal cells, and their distribution on the lamina distinguish this from other Australian *Breutelia* species. It can be separated from *Breutelia* sp. A by the numerous quadrate alar cells that extend one-third the length of leaf. Moreover, *B. affinis* also has a more ovate-lanceolate leaf shape and an abruptly tapered apex.

Breutelia affinis differs from *B. pseudophilonotis* in having numerous alar cells, thin-walled and irregular mid-leaf laminal cells, broader leaves and significantly smaller spores.

2. **Breutelia elongata** (Hook.f. & Wilson) Mitt., *Fragm.* 11 (Suppl.): 114 (1881)

Hypnum elongatum Hook.f. & Wilson, *London J. Bot.* 3: 551 (1844); *Bartramia elongata* (Hook.f. & Wilson) Mitt., *Handb. New Zealand Fl.* 449 (1867); *Prionodon elongatus* (Hook.f. & Wilson) A.Jaeger, *Ber. Tätigk. St. Gallischen Naturwiss. Ges.* 1875–76: 223 (1877). T: Lord Aucklands group [Auckland Is.] and Campbell Is; syn: BM? *n.v.*

Bartramia crassa Hook.f. & Wilson, *in* J.D.Hooker, *Fl. Tasman.* 2: 194 (1859); *Breutelia crassa* (Hook.f. & Wilson) A.Jaeger, *Ber. Tätigk. St. Gallischen Naturwiss. Ges.* 1873–74: 94 (1875). T: Top of Western Mtns, Mt Wellington., Tas.; creek above the Wellington Falls, Tas., *R.C.Gunn*; *A.F.Oldfield 101, 104, 106, 111*; syn: NY? *n.v.*

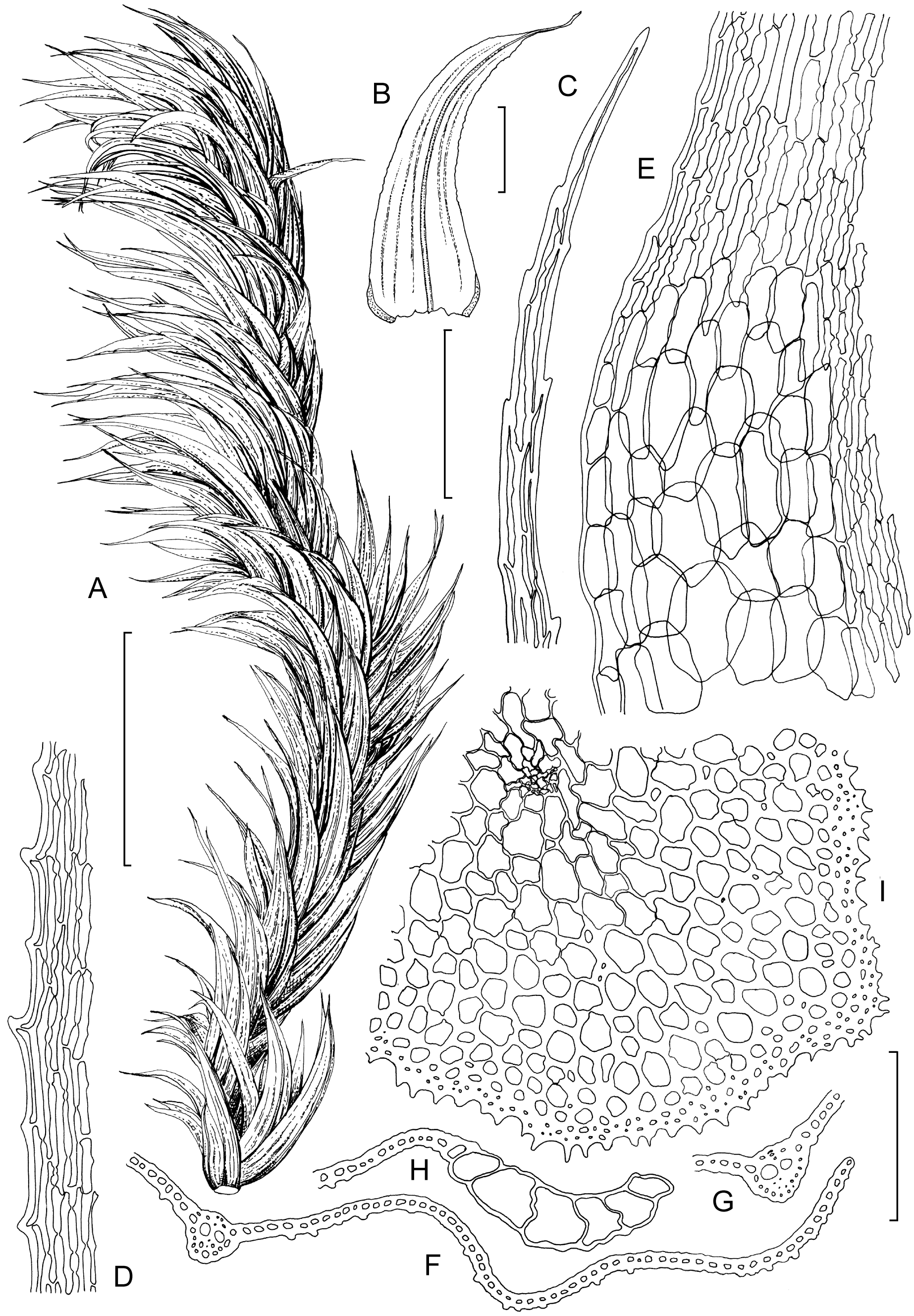

Figure 33. *Breutelia elongata*. **A**, Habit; **B**, Stem leaf; **C**, Cells of leaf apex; **D**, Marginal cells of upper part of leaf; **E**, Cells from basal angle of leaf; **F**, **G**, sections of leaf and costa; **H**, Section of alar cells; **I**, Section of part of stem. Scale bars: 5 mm for plant; 1 mm for leaf; 100 µm for cells and sections. Drawn by R.D.Seppelt. Reproduced from *The Moss Flora of Macquarie Island* 69 (2004).

Illustrations: G.A.M.Scott & I.G.Stone, *The Mosses of Southern Australia* 333, pl. 62 (1976); R.D.Seppelt, *The Moss Flora of Macquarie Island* 69, fig. 27 (2004).

Stems to c. 8 cm long, simple to sparingly branched. Leaves imbricate, erect-spreading to squarrose or appressed at the base and spreading above when dry, ovate-lanceolate, tapering gradually to an acuminate apex, deeply and evenly plicate throughout leaf, ±falcate and secund, 4.0–5.4 mm long, 0.9–1.3 mm wide; margin plane or slightly recurved below, serrulate to serrate above; costa percurrent to short-excurrent; mid-leaf laminal cells regular, linear with rounded ends, 18–40 (–60) × 4–5 µm, longer below, porose, thick-walled (wall to c. 6 µm); alar cells usually in 5 or 6 rows, inflated, short-rectangular, 20–50 × c. 15 µm. Setae to 35 mm long. Capsules sulcate when dry, inclined. Spores c. 20–22 µm diam. Fig. 33.

Occurs in Tas.; also in New Zealand and on Subantarctic islands, including Macquarie Is. This moss grows on soil and occasionally on rock in very moist conditions; often found growing with *Sphagnum*. Map 137.

Tas.: Lake Hwy, 22 km SSE of Deloraine, *J.A.Curnow 2389* (CANB); Mount Field Natl Park, *A.V.Ratkowsky H138* (CANB); Cradle Mountain Natl Park, *D.McVean 267119* (CANB).

Breutelia elongata can be confused with the very similar *B. pendula*. However, the former has more densely packed leaves, thicker-walled porose laminal cells, a usually more rounded leaf base due to a thinner point of attachment and more deeply and evenly plicate leaves. The width of the costa base in *B. elongata* is often much narrower (30–40 µm) than in *B. pendula* [(30–) 58–90 µm].

3. **Breutelia pendula** (Sm.) Mitt., *J. Proc. Linn. Soc., Bot.* 4: 82 (1860)

Mnium pendulum Sm., *Trans. Linn. Soc. London* 7: 262 (1804); *Bartramia pendula* (Sm.) Hook., *Musci Exot.* 1: 121 (1818). T: “Dusky Bay” [Dusky Sound], New Zealand, 1791, *A.Menzies*; BM? *n.v.*

Bartramia sieberi Hornsch. ex Müll.Hal., *Syn. Musc. Frond.* 1: 491 (1849); *Breutelia sieberi* (Hornsch. ex Müll.Hal.) Mitt., *J. Proc. Linn. Soc., Bot.* 4: 83 (1860). T: “Nova Hollandia” [Australia], *F.Sieber*; holo: *n.v.*

Bartramia comosa Mitt., *in* J.D.Hooker, *Fl. Tasman.* 2: 194 (1859); *Breutelia comosa* (Mitt.) Mitt., *J. Proc. Linn. Soc., Bot.* 4: 82 (1860). T: East Ck, and Cumming’s Head, Western Mtns, [Tas.], *W.Archer*; syn: NY *n.v.*; Wellington Falls, Mt Wellington, [Tas.], *S.Mossman 744*; syn: NY *n.v.*

Bartramia divaricata Mitt., *in* J.D.Hooker, *Fl. Tasman.* 2: 195 (1859); *Breutelia divaricata* (Mitt.) Mitt., *J. Proc. Linn. Soc., Bot.* 4: 83 (1860). T: Chestnut, [Tas.], *W.Archer*; holo: NY *n.v.*

Bartramia reflexa Müll.Hal., *Rev. Bryol.* 24: 73 (1897); *Breutelia reflexa* (Müll.Hal.) Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 161 (1906). T: Tingiring, N.S.W., 1889, *W.Baeuerlen*; iso?: MEL (not located).

Breutelia fuscoaurea Broth., *Oefvers. Förh. Finska Vetensk.-Soc.* 42: 103 (1900). T: Lawson, N.S.W., *A.A.Hamilton 88*; holo: H-BR *n.v.*; iso: NSW *n.v.*

Bartramia comiramea Müll.Hal., *Genera Musc. Frond.* 344 (1901); *Breutelia comiramea* Müll.Hal., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 159 (1906), *nom. inval.* (in synon.). T: not known.

Bartramia campbelliana Müll.Hal., *Genera Musc. Frond.* 348 (1901); *Breutelia campbelliana* (Müll.Hal.) Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 158 (1906). T: Hume R., Vic., *F.M.Campbell*; holo: BM; iso: NSW.

Illustrations: J.Beever, K.W.Allison & J.Child, *Mosses of New Zealand*, 2nd edn 105, fig. 47 (1992); R.D.Seppelt, *The Moss Flora of Macquarie Island* 71, fig. 28 (2004).

Stems to 14 cm long, simple to sparingly branched. Leaves imbricate, erecto-patent to squarrose when dry, lanceolate, gradually tapering to an acuminate apex, plicate throughout, 2.6–3.8 (–5.8) mm long, 0.7–1.1 (–1.6) mm wide; margin plane to slightly recurved below, serrulate above; costa percurrent to short-excurrent; mid-leaf laminal cells irregular, linear with rounded ends, short-rectangular or isodiametric, (8–) 10–42 × 4–6 µm; cell walls thin to thick, c. 2–6 µm; alar cells inflated, c. 2–7 rows, rectangular to short-rectangular, 20–50 × 10–18 µm. Setae c. 15 mm long. Capsules inclined to almost pendulous, ovoid to cylindrical, sulcate when dry. Spores c. 22–24 µm diam. $n = 6$, *fide* H.P.Ramsay, *Austral. J. Bot.* 22: 318 (1974). Plate 29.

Occurs in N.S.W., A.C.T., Vic. and Tas.; also in New Zealand, Macquarie Is., South Africa, South America, New Guinea and Sulawesi. In Australia it is found in very moist conditions, usually at higher elevations. Map 138.

N.S.W.: Gang Gang Ck, 17 km NW of Adaminaby, *H.Streimann 7371* (CANB). A.C.T.: Snowy Flats, 1.5 km NNE of Mt Gingera, *M.D.Crisp 2030* (CANB). Vic.: Mt Baw Baw, 24 km ENE of Noojee, *H.Streimann 50827* [*Musci Australas. Exsicc.* 181] (CANB). Tas.: Pipeline Track, Mt Wellington, *A.V.Ratkowsky H142* (CANB).

Breutelia pendula is most similar to *B. elongata*; their differences are discussed under that species.

This species was listed for W.A. and Qld by H.Streimann & N.Klazenga (*Cat. Austral. Mosses* 28, 2002). However, no specimens could be examined to confirm these reports.

4. Breutelia pseudophilonotis (Müll.Hal.) Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 161 (1906)

Bartramia pseudophilonotis Müll.Hal., *Genera Musc. Frond.* 342 (1901); *Philonotis pseudophilonotis* (Müll.Hal.) Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 156 (1906). T: Balls Head Bay, N.S.W., Aug.–Oct. 1884, *T.Whitelegge*; iso: NSW.

?*Bartramia atrata* Müll.Hal., *Genera Musc. Frond.* 342 (1901), *nom. nud.*; *Breutelia atrata* Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 158 (1906). T: N.S.W. *n.v.* ?type in Manchester Museum herbarium, *fide* G.C.S.Clark, *Manchester Mus. Publ.* 2.73: 1–20 (1973).

Stems c. 5 cm long (rarely to 15 cm), simple to richly branched (especially towards the tips). Leaves imbricate, erecto-patent to spreading, rarely squarrose when dry, narrowly lanceolate to lanceolate, gradually tapering to an acuminate apex, sometimes plicate at base, (1.9–) 2.3–3.9 mm long, 0.3–0.7 mm wide; margin plane throughout, occasionally slightly recurved below, serrate (rarely serrulate) above; costa long-excurrent; mid-leaf laminal cells regular, rectangular to linear, 42–90 × 3–5 µm, porose, thick-walled (wall 4–6 µm); alar cells apparently absent or in c. 3 or 4 rows of up to 5 cells, subquadrate to short-rectangular, to 30 × 10 µm. Setae c. 15 mm long. Capsules erect to inclined or horizontal, ovoid to cylindrical, sulcate when dry. Spores 44–60 µm diam. Fig. 34, Plates 30, 31.

An endemic species in N.S.W., A.C.T., Vic. and Tas.; grows on damp to very moist rock and soil. Map 139.

N.S.W.: near Mt Imlay trig., *M.D.Crisp 3489* (CANB); Braeside Walk, Blue Mountains Natl Park, *F.E.Davies 325* (CANB). A.C.T.: Australian National Botanic Gardens, Canberra, *H.Streimann 2114* (CANB). Vic.: Kalymna Falls, Grampians Natl Park, *H.Streimann 55219* (CANB). Tas.: near Devils Gate Dam, Kentish Municipality, *D.H.Norris 27200* (CANB).

Most herbarium specimens of *B. pseudophilonotis* have been incorrectly labelled as *B. pendula*. However, the former is clearly distinct, having lanceolate leaves that are plicate only at the base (if at all), alar cells absent or subquadrate and not inflated, mid-leaf laminal cells that are commonly elongate, porose, thick-walled and regular, serrate upper leaf margins and distinctly larger spores.

5. Breutelia sp. **A**

Stems to 6 cm long, variously branched, most commonly towards the apices. Leaves imbricate, erect-spreading when dry, lanceolate, gradually tapering to a broadly acuminate apex, plicate only at the base, 2.2–2.7 mm long, 0.47–0.62 mm wide; margin recurved below, denticulate or serrulate and plane above; costa excurrent to long-excurrent; mid-leaf laminal cells regular in shape and size, short-rectangular with rounded ends, 14–30 × c. 4 µm, thin-walled (wall c. 2 µm thick); subquadrate alar cells usually present (c. 10 µm wide), with up to 8 rows extending one-fifth the height of the lamina. Sporophyte unknown.

Four specimens are known from two localities above 1260 m in eastern N.S.W. Map 140.

N.S.W.: Gloucester Tops, *H.Streimann 439*, *44075*, *44078* (CANB); Peppercorn Hut, 48 km NNW of Adaminaby, *H.Streimann 1685* (CANB).

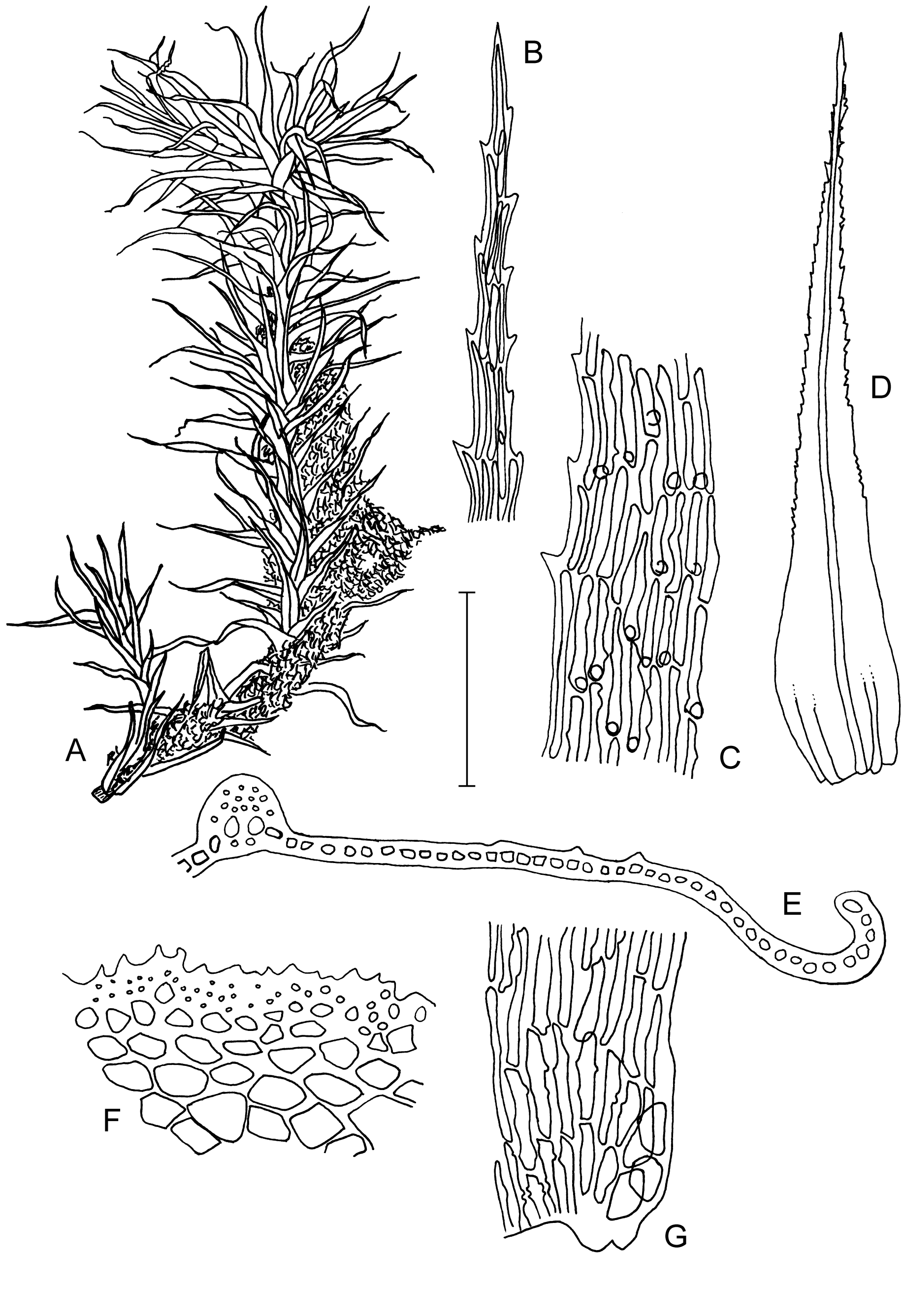

Figure 34. *Breutelia pseudophilonotis*. **A**, Habit; **B**, Leaf apex; **C**, Mid-leaf cells; **D**, Leaf; **E**, T.S. of mid-leaf; **F**, T.S. of stem showing denticulate margin; **G**, Basal marginal leaf cells showing reduced alar section. All from *F.E.Davis 325* (CANB). Scale bars: 5 mm in A; 100 μm in B, C, E–G; 800 μm in D. Drawn by S.R.Gilmore.

In terms of vegetative morphology and anatomy this entity is most similar to *B. affinis*. It differs in the lanceolate leaf shape, gradually tapering apex, reduced alar regions extending to only one-fifth the height of the lamina, and the more uniform size and shape of mid-leaf laminal cells. However, in the absence of sporophytes I am reluctant to describe it as new.

Doubtful Names

The following names are likely to fall into synonymy with accepted species documented above. In all cases original descriptions are too vague and the type collections are likely to have been destroyed in B (March 1943).

Breutelia baeuerlenii (Müll.Hal.) Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 158 (1906)

Bartramia baeuerlenii Müll.Hal., *Genera Musc. Frond*. 351 (1901). T: Clyde R., N.S.W., *W.Baeuerlen*; holo: *n.v.*

Breutelia crawfordii (Müll.Hal.) Watts. & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 161 (1906), *nom. nud.*

Bartramia crawfordii Müll.Hal., *Genera Musc. Frond*. 347 (1901), *nom. nud.* Based on: Apsley R., New England, N.S.W., *Crawford*; *n.v.*

Breutelia leptodontoides (Müll.Hal.) Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 160 (1906)

Bartramia leptodontoides Müll.Hal., *Genera Musc. Frond.* 347 (1901). T: N.S.W.; *n.v.*

Breutelia lonchopelma (Müll.Hal.) Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 160 (1906)

Bartramia lonchopelma Müll.Hal., *Genera Musc. Frond*. 355 (1901). T: Snowy R., Gippsland, [Vic.], *coll. unknown*; holo: *n.v.*

Breutelia luteola Müll.Hal. ex Broth., *Rev. Bryol*. 24: 73 (1897)

Breutelia luteola Müll.Hal., *Rev. Bryol.* 3: 4 (1876), *nom. nud*.; *Bartramia luteola* (Müll.Hal. ex Broth.) Müll.Hal., *Genera Musc. Frond.* 347 (1901). T: near Sydney, N.S.W., *D.Kayser*, *n.v.*; Delegate District, N.S.W., *W.Baeuerlen*, *n.v.*

Breutelia witherheadii (Müll.Hal.) Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 161 (1906)

Bartramia witherheadii Müll.Hal., *Genera Musc. Frond*. 347 (1901). T: New England, N.S.W., *Witherhead*; holo: *n.v.*

3. CONOSTOMUM

Scott R. Gilmore[1]

Conostomum Sw., *Naturh. Reise Schwed.* 122 (1804); from the Greek *cono* (conical) and *stoma* (a mouth), in reference to the perforated cone formed by the fused tips of the peristome teeth.

Type: *C. articum* Sw. [= *C. tetragonum* (Brid.) Lindb.]

[1] c/- Australian Biological Resources Study, GPO Box 787, Canberra, Australian Capital Territory 2601.

Monoicous. Plants sparingly to densely tufted, bright green to yellow-green above, brown below. Stems simple to fastigately branched; tomentose below. Rhizoids smooth, red-brown. Leaves 5-ranked, imbricate, erect to erect-spreading, usually lanceolate; margin plane or recurved, denticulate; costa excurrent to long-excurrent, varying in width at leaf base; laminal cells rectangular, smooth or with apical papillae; alar cells not differentiated. Capsules erect to horizontal, globose, ovoid or short-cylindrical; operculum beaked and sloping to one side. Peristome absent or single; exostome teeth 16, joined apically. Spores large, globose, reniform or ovoid, papillose-warty. $n = 8$; H.P.Ramsay, *in* A.Löve, *Taxon* 16: 557 (1967).

The world revision by Frahm *et al.* (1996) reduced the 15 previously accepted species to seven. More recently, Fife (1998) and Virtanen (1999) published revisions of the New Zealand and Papua New Guinean species which disagreed with Frahm *et al.* on the synonymy of *C. pusillum* and *C. pentastichum* with the Northern Hemisphere species *C. tetragonum*. This treatment of Australian material agrees with the conclusions of Fife and Virtanen.

J-P.Frahm, H.Börner, N.Streiber, B.Wallau & S.Weitkus, Revision der Gattung *Conostomum* (Musci, Bartramiaceae), *Trop. Bryol.* 12: 97–114 (1996); A.J.Fife, A synopsis of the New Zealand representatives of *Conostomum* (Musci: Bartramiaceae), *New Zealand J. Bot.* 36: 605–615 (1998); V.Virtanen, Bryophyte flora of the Huon Peninsula, Papua New Guinea. LX. *Bartramia*, *Conostomum* and *Leiomela* (Bartramiaceae, Musci), *Acta Bot. Fenn.* 165: 1–15 (1999).

1 Plants less than 5 mm tall; leaves 0.5–0.9 mm long; capsules wrinkled; peristome absent .... **1. C. curviroste**

1: Plants usually more than 5 mm tall; leaves 0.75–2.40 mm long; capsules sulcate; peristome present 2

  2 Costa well-defined, occupying c. one-third of leaf base; leaves not clearly in ranks of 5 *(1:)* .... **3. C. pusillum**

  2: Costa broad and poorly defined, occupying c. two-thirds of leaf base; leaves usually clearly 5-ranked, especially on the lower parts of the stem .... **2. C. pentastichum**

1. Conostomum curvirostre (Mitt.) Mitt., *Trans. & Proc. Roy. Soc. Victoria* 19: 68 (1882)

Bartramia curvirostris Mitt., *Hooker's J. Bot. Kew Gard. Misc.* 8: 260 (1856), as *B. curvirostra*. T: Munyang Mtns, Australian Alps, [Vic.], 1885, *F.Mueller 83*; syn: MEL, NY *n.v.*, *fide* J.-P.Frahm *et al.*, *Trop. Bryol.* 12: 100 (1996); syn: BM, CHR *n.v.*, *fide* A.J.Fife, *New Zealand J. Bot.* 36: 606 (1998).

Illustration: A.J.Fife, *op. cit.* 607, fig. 1 (1998).

Plants small. Stems simple, 2–4 mm tall (rarely taller), green to red-brown. Leaves lanceolate to triangular-lanceolate, rarely ovate-lanceolate, acuminate, 0.5–0.9 mm long, 0.1–0.2 mm wide; margins denticulate above; costa well-defined, excurrent, bluntly denticulate dorsally towards the apex, multistratose costal wings absent, occupying up to one-third of the leaf base; laminal cells rectangular, smooth to prorate, losing shape near the apex and margin, 20–55 × 10–12 µm. Perigonia located below the perichaetium. Perichaetial leaves large, lanceolate; margin serrulate towards apex; basal cells elongate. Setae to 7 mm long. Capsules erect, globose, unevenly wrinkled. Peristome absent. Spores globose, ovoid or reniform, densely warty, 36–50 µm diam.

Occurs on soil at high altitudes in N.S.W., A.C.T. and Vic.; also in New Zealand (South Island). Map 141.

N.S.W.: Etheridge Ra., 1 km NE of Mt Kosciuszko, *D.J.Wimbush 45* (CANB). A.C.T.: Mt Bimberi, *H.Streimann 4362* (CANB). Vic.: "Ruined Castle", Bogong High Plains, *H.Streimann 53525* (CANB).

The capsules of this commonly fruiting moss are sometimes slightly furrowed rather than wrinkled. The lack of a peristome, along with the usually wrinkled capsule and comparatively small size are diagnostic.

2. Conostomum pentastichum (Brid.) Lindb., *Öfvers. Förh. Kongl. Svenska Vetensk.-Akad.* 20: 392 (1863)

Bartramia pentasticha Brid., *Muscol. Recent.* 2(3): 134 (1803). T: ad stretum Magellanicum, *P.Commerson*, ex Herb. Swartz; holo: BM *n.v.*, *fide* A.J.Fife, *op. cit.* 609 (1998); B? *n.v.*, *fide* J.-P.Frahm *et al.*, *op. cit.* 106 (1996).

Conostomum australe Sw., *J. Bot. (Schrader)* 1(3): 31 (1806); *Philonotis australis* (Sw.) Mitt., *J. Proc. Linn. Soc., Bot.* 4: 81 (1860); *Bartramia australis* (Sw.) Mitt., *J. Linn. Soc., Bot.* 12: 267 (1869). T: as for *Bartramia pentasticha*.

Illustrations: A.J.Fife, *op. cit.* 609, fig. 3 (1998); J.Beever, K.W.Allison & J.Child, *Mosses of New Zealand*, 2nd edn 104, fig. 46 (1992); R.D.Seppelt, *The Moss Flora of Macquarie Island* 73, fig. 29 (2004).

Plants small to medium. Stems simple to fastigiate, red to red-brown, to c. 20 mm tall. Leaves distinctly 5-ranked, lanceolate to linear-lanceolate, acuminate, 1.75–2.40 mm long, 0.33–0.56 mm wide; margin recurved and denticulate above; costa excurrent to long-excurrent, toothed dorsally by projecting cell ends, poorly defined due to the presence of multistratose costal wings that extend to within 5–9 cells of the margin, occupying c. two-thirds of the leaf base; laminal cells poorly defined, rectangular, 30–60 × 4–10 µm, prorate; lower cells longer. Perigonia and perichaetia terminal. Perichaeital leaves similar to stem leaves but with a markedly thinner costa. Setae c. 20 mm long. Capsules inclined to horizontal, globose to ovoid, sulcate. Peristome single; exostome teeth red, long-triangular-lanceolate, trabeculate, smooth, joined at the apices. Spores subglobose to reniform, 58–60 µm diam. Plates 32, 33.

This species is found on soil in alpine and subalpine regions. It has been reported from A.C.T., Vic. and Tas., but I have only seen specimens from Tas., and I consider mainland records of *C. pentastichum* doubtful due to previous confusion with *C. pusillum*. *Conostomum pentastichum* is also found in New Zealand, Macquarie Is., Auckland Is., Campbell Is., South America and southern Africa. Map 142.

Tas.: Zig Zag Track, Mt Wellington, *A.V.Ratkowsky H171* (CANB); L. Fenton, Mount Field Natl Park, *D.H.Norris 28545* (CANB).

Frahm *et al.* (1996) included *C. giganteum* in the Australian flora, but Fife (1998) synonymised it with *C. pentastichum*. A duplicate of the specimen cited by Frahm *et al.* (*H.Streimann 4371*, CANB) is a large *C. pusillum*. It has been included in the Australian flora as a misapplied name under that species.

3. Conostomum pusillum Hook.f. & Wilson, *in* J.D.Hooker, *Fl. Nov.-Zel.* 2: 88 (‘1855’) [1854]

var. **pusillum**

Bartramia pusilla (Hook.f. & Wilson) Mitt., *Hooker’s J. Bot. & Kew Gard. Misc.* 8: 260 (1856), *nom. illeg.*; *Philonotis pusilla* (Hook.f. & Wilson) Mitt., *J. Proc. Linn. Soc., Bot.* 4: 81 (1860). T: Top of the Ruahine Mountains, [New Zealand], *W.Colenso 2746*; holo: BM *n.v.*, *fide* A.J.Fife, *New Zealand J. Bot.* 36: 611 (1998).

Conostomum parvulum Hampe, *Linnaea* 28: 207 (1856). T: In rupibus montium Grampians et in monte Cobboras, 6000’, [Vic.], *coll. unknown*; holo: BM *n.v.*, *fide* A.J.Fife, *op. cit.* 613 (1998).

[*Conostomum giganteum auct. non* E.B.Bartram & Dixon: J.-P.Frahm *et al.*, *Trop. Bryol.* 12: 100 (1996)]

Illustrations: A.J.Fife, *op. cit.* 612, fig. 5g–k (1998); D.Meagher & B.Fuhrer, *Field Guide to the Mosses and Allied Plants of Southern Australia* 109 (2003).

Plants small to medium. Stems simple to fastigately branched, red to red-brown, to c. 6 mm long. Leaves triangular or linear-lanceolate, acuminate, 0.73–1.90 mm long, 0.15–0.37 mm wide; margin recurved and denticulate above; costa well-defined, excurrent to long-excurrent, toothed dorsally by projecting cell ends, occupying c. one-third of the leaf base (rarely half), without multistratose costal wings (rarely with small wings blurring costa edges); laminal cells rectangular, 26–44 × 6–10 µm, prorate; lower cells more elongate. Perigonia most commonly just below perichaetia. Perichaetia in branch axils; leaves similar to those on the stem. Setae 9–20 mm long. Capsules erect to inclined or, rarely, pendulous, globose to ovoid, sulcate. Peristome single; exostome teeth red, long-triangular-lanceolate,

trabeculate, smooth, joined at the apices. Spores globose, reniform or ovoid, c. 58 µm diam. n = 8 [Blackheath, N.S.W., *Ramsay 56/64* (SYD)].

This species grows on soil in alpine or subalpine regions of N.S.W., A.C.T., Vic. and Tas.; also in New Zealand. Map 143.

N.S.W.: Charlotte Pass, Mount Kosciuszko Natl Park, *D.H.Vitt 26783* (CANB). A.C.T.: Mt Aggie, Brindabella Ra., *D.Verdon 1020* (CANB). Vic.: Dargo High Plains Rd, 6 km SW of Mt Hotham, *H.Streimann 57340* [*Musci Australas. Exsicc.* 531] (CANB). Tas.: L. Dobson, *D.McVean 267113* (CANB).

Conostomum pusillum and *C. pentastichum* are readily separated. The leaves of the latter are distinctly 5-ranked, especially lower on the stem, and the poorly defined costa is comparatively broad. In contrast, the leaves of *C. pusillum* are not as obviously 5-ranked due to slight twisting of the leaves around the stem, and the costa is well-defined, narrower and scarcely winged. Sterile specimens of *C. pusillum* can be difficult to distinguish from *Philonotis tenuis* which differs in the occasional presence of subquadrate outer basal cells, papillose rhizoids, and the absence of 5-ranked leaves.

4. PHILONOTIS

Scott R. Gilmore[1]

Philonotis Brid., *Bryol. Univ.* 2: 15 (1827); presumably from the Greek *philo* (loving), and *notis* (dampness or water), in reference to the moist places in which this moss grows.

Type: *P. fontana* (Hedw.) Broth.

Dioicous. Plants very small to medium-sized or large, densely tufted. Stems simple, sparingly branched, or with subfloral innovations, tomentose below; rhizoids ±lightly papillose. Leaves unranked, densely imbricate to widely spread on stems, erect to squarrose, rarely slightly twisted, unchanged when dry or wet, ovate-lanceolate to linear-lanceolate, acuminate to acute; margin plane or recurved, denticulate-papillose to serrate; costa usually strong, failing below apex to long-excurrent; laminal cells rectangular to long-hexagonal, commonly with subquadrate basal marginal cells, ±papillose (usually from projecting cells ends); apical cells usually longer and narrower than basal cells. Capsules erect to pendulous, subglobose to short-cylindrical; operculum convex, with or without an umbo. Peristome absent or double; exostome teeth 16; endostome irregular. Spores globose, reniform or ovoid, densely papillose. n = 6, *fide* H.P.Ramsay, *in* A.Löve *Taxon* 16: 557 (1967), as *Philontois harrisii* Geh., *nom. nud.*; Eungella Range, Qld, H.P.*Ramsay 58/63* (SYD).

A genus of c. 170 species worldwide; seven are recognised in Australia, and three are endemic. Griffin & Buck (1989) synonymised *Bartramidula* Bruch & Schimp. with *Philonotis*. Scott & Stone (1976) describes the genus as having a high degree of plasticity within species, and with numerous *nomina nuda* the genus requires further revision in Australia.

While the genus is readily recognised, differentiation between the species can be difficult. Plants are either yellow-green or, in the case of *P. scabrifolia*, white to glaucous green. Tomentum is often irregular and patchy on the lower half of the stem.

T.Koponen & D.Norris, Bryophyte flora of the Huon Peninsula, Papua New Guinea. LVII. *Fleischerobryum* and *Philonotis* (Bartramiaceae, Musci), *Acta Bot. Fenn*. 156: 1–21 (1996).

1 Plants very small; laminal cells smooth .... **1. P. australiensis**

1: Plants usually larger; laminal cells papillose 2

  2 Laminal cells with a large central papilla; plants white to glaucous green *(1:)* .... **5. P. scabrifolia**

  2: Laminal cells papillose from projecting cell ends; plants usually yellow-green 3

3 Costa failing below apex *(2:)* 4

3: Costa percurrent to excurrent 5

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[1] c/- Australian Biological Resources Study, GPO Box 787, Canberra, Australian Capital Territory 2601.

4 Leaves lanceolate; apex acute *(3)*..........**2. P. hastata**
4: Leaves linear-lanceolate; apex broadly acuminate .... **3. P. pallida**
5 Leaves narrowly triangular-lanceolate; costa long-excurrent *(3:)*.......... **6. P. slateri**
5: Leaves triangular-lanceolate to ovate-lanceolate; costa percurrent to excurrent..........6
6 Leaf margin recurved; apex acute to acuminate *(5:)* ....**7. P. tenuis**
6: Leaf margin plane; apex acute .... **4. P. pyriformis**

1. Philonotis australiensis D.G.Griffin & W.R.Buck, *Bryologist* 92: 376 (1989)

Glyphocarpa pusilla Hook.f. & Wilson, *London J. Bot.* 3: 544 (1844); *Bartramia pusilla* (Hook.f. & Wilson) Müll.Hal., *Syn. Musc. Frond.* 1: 480 (1848); *Bartramidula pusilla* (Hook.f. & Wilson) Paris, *Index. Bryol.* 116 (1894). T: Tas., *D.Lyall*; holo: BM? *n.v.*

Bartramidula weymouthii Broth., *Pap. & Proc. Roy. Soc. Tasmania* 1902: 115 (1903); *Bartramidula pusilla* var. *weymouthii* (Broth.) Rodway, *Pap. & Proc. Roy. Soc. Tasmania* 1913: 194 (1914). T: on roadside bank, Port Cygnet, Lymington, Tas., Sept. 1889, *W.A.Weymouth*; holo: H-BR *n.v.*

Illustrations: D.G.Catcheside, *Mosses of South Australia* 286, fig. 171 (1980), as *Bartramidula pusilla*; D.Meagher & B.Fuhrer, *Field Guide to the Mosses and Allied Plants of Southern Australia* 165 (2003).

Plants very small, to 5 mm tall, tufted, pale to glaucous green above, yellow to brown below. Stems erect, rarely branched. Leaves erect-spreading, ovate-lanceolate to linear-lanceolate, acuminate, 0.22–0.60 mm long, 0.115–0.200 mm wide; margin entire to bluntly denticulate above; costa failing below apex; laminal cells short-rectangular, losing shape towards apex and margin, thick-walled, smooth, 12–60 × 7–6 µm. Setae erect, to 10 mm long. Capsules erect to pendulous, globose to oblong, rarely urceolate, wrinkled or occasionally slightly furrowed; operculum convex, umbonate. Peristome absent. Spores globose, densely papillose, 44–70 µm diam.

This minute, endemic species occurs in W.A., S.A., Vic. and Tas. It has been reported from N.S.W. (Scott & Stone, 1976), but no specimens could be examined to confirm this; however, its occurrence there is not unlikely. *Philonotis australiensis* grows on moist soils in sheltered habitats. Map 144.

W.A.: Preston R., *D.H.Norris 25667* (CANB). S.A.: 13 km NE of Cleve, *H.Streimann 54692* [*Musci Australas. Exsicc.* 380] (CANB). Vic.: Teddys Lookout, Lorne, *W.W.Watts 1080* (NSW). Tas.: Mt Wellington, *W.A.Weymouth 550* (CANB).

2. Philonotis hastata (Duby) Wijk & Margad., *Taxon* 8: 74 (1959)

Hypnum hastata Duby, *in* A.Moritzi., *Syst. Verz.* 132 (1846). T: locality unknown; *n.v.*

Philonotis imbricatula Mitt., *J. Proc. Linn. Soc., Bot.*, Suppl. 1: 61 (1859); *Bartramia imbricatula* (Mitt.) Müll.Hal., *Linnaea* 36: 12 (1869). T: Ceylon [Sri Lanka], *Gardner*; lecto: NY *n.v.*, *fide* T.Koponen & D.H.Norris, *Acta Bot. Fenn.* 156: 7 (1996).

Philonotula jardinii Besch., *Ann. Sci. Nat. Bot.*, sér. 7, 20: 29 (1894); *Philonotis jardinii* (Besch.) Paris, *Index. Bryol.* 923 (1897). T: Tahiti, Society Islands, 1852 ex Herb. E.Jardin; holo: BM *n.v.*, *fide* T.Koponen & D.H.Norris, *Acta Bot. Fenn.* 156: 7 (1996).

Bartramia laxissima Müll.Hal., *Syn. Musc. Frond.* 1: 480 (1849), *nom. illeg.*; *Philonotis laxissima* (Müll.Hal.) Mitt., *J. Proc. Linn. Soc., Bot.*, Suppl. 1: 61 (1859), *nom. illeg.* T: Java, [Indonesia]; homotypic with *P. hastata*, *fide* T.Koponen & D.H.Norris, *Acta Bot. Fenn.* 156: 7 (1996).

Illustration: T.Koponen & D.H.Norris, *op. cit.* 8, fig. 3 (1996).

Plants usually densely tufted. Stems minute, c. 5 mm tall, sparingly branched. Leaves imbricate, erect to erect-spreading, lanceolate, acute, 0.55–0.71 mm long, 0.15–0.27 mm wide; margin recurved towards apex, entire to crenulate at base, doubly denticulate-papillose to serrulate above; costa weak, usually failing below apex, denticulate-papillose; basal laminal cells mostly subquadrate to short-rectangular, mammillose; basal cells closer to costa elongate-rectangular, smooth, 14–44 × 7–14 µm; apical cells generally narrower, rectangular to rhomboidal, papillose by projecting cell ends, 25–46 × 6–14 µm. Sporophyte not seen.

This species grows on rocks in Qld. It has also been reported for N.T., but no specimens were available to confirm this; also in Lord Howe Is., SE Asia, Malesia and Madagascar. Map 145.

Qld: Fishery Ck, *H.Flecker 2172* (CANB); North Toohey Ck, *H.Flecker 3381* (CANB); Freshwater Ck, Cairns Intake, *H.Flecker 5253* (CANB).

The leaves of *P. hastata* are comparatively short and broad. This, along with the short costa and the acute apex, distinguish it from other Australian species.

3. **Philonotis pallida** (Hampe) A.Jaeger, *Ber. Tätigk. St. Gallischen Naturwiss. Ges.* 1877–78: 437 (1879)

Bartramia pallida Hampe, *Linnaea* 40: 307 (1876). T: subtropical east Australia, [Qld], *Eaves*; holo: *n.v.*

Plants slightly tufted. Stems c. 25 mm tall, string-like. Leaves widely spaced on the stem, wide-spreading, less commonly erect-spreading, linear-lanceolate, broadly acuminate, 0.6–0.9 mm long, 0.11–0.15 mm wide; margin plane to slightly recurved, singly or doubly serrate from the base, less commonly denticulate-papillose; costa failing below apex, denticulate-papillose dorsally towards the apex; outer basal laminal cells short-rectangular; inner basal cells rectangular, rarely hexagonal, 26–42 × 6–9 µm; upper cells 26–40 × 4–6 µm, papillose by projecting cell ends. Sporophyte not seen.

This very rare endemic species occurs in Qld and on soil in Vic. Map 146.

Vic.: Mt William, *coll. unknown* (NSW 416473, 416474).

Few cells are found between the costa and the margin as the leaves are quite narrow. The leaf apices are also rather narrow but somewhat rounded.

4. **Philonotis pyriformis** (R.Br.bis) Wijk & Margad., *Taxon* 11: 222 (1962)

Bartramia pyriformis R.Br.bis, *Trans. & Proc. New Zealand Inst.* 32: 146 (1900). T: Rocks dripping with water, near Lake Te Anau; New Zealand, Jan. 1890, *R.Brown*; holo: *n.v.*

Plants densely tufted, 2–20 cm tall. Leaves imbricate, erect-spreading to squarrose, often falcate-secund, lanceolate, acute, 1.5–2.3 mm long, 0.4–0.8 mm wide; margin plane, singly denticulate-papillose to serrate; costa short-excurrent, denticulate-papillose dorsally towards the apex; laminal cells rectangular or long-hexagonal; basal cells 50–108 × 10–22 µm; upper cells 21–96 × 6–12 µm, papillose due to projecting cell ends. Sporophyte not seen.

Occurs on rock in very moist habitats in eastern Vic.; also in New Zealand. Map 147.

Vic.: Greens Ck, Waterfall, *C.B.Kay* (MEL 1036824); between Mt Beauty and Bogong, *C.B.Kay* (MEL 1025346); Greens Ck, 3 miles [c. 4.8 km] NE of Bogong, *C.B.Kay* (MEL 1036823).

This species can be very similar to *P. tenuis*, but it is more robust, and the leaves are more often falcate-secund. The costa is short-excurrent from an acute apex, while *P. tenuis* usually has a finer apex. Scott & Stone (1976) listed this as “Tas (doubtful)”, and while I have seen many Tasmanian specimens of *Philonotis*, none were of *P. pyriformis*.

5. **Philonotis scabrifolia** (Hook.f. & Wilson) Braithw., *Brit. Moss. Fl.* 2: 215 (1895)

Hypnum scabrifolium Hook.f. & Wilson, *London J. Bot.* 3: 552 (1844); *Fl. Antarct.* 1: 138: 60, fig. 6 (1844). T: Lord Auckland’s group [Auckland Is.], *D.Lyall 26*; holo: BM.

Bartramia appressa Hook.f. & Wilson, *in* J.D.Hooker, *Fl. Nov.-Zel.* 2: 89, t. LXXXVI, fig. 5 (‘1855’) [1854]; *Philonotis appressa* (Hook.f. & Wilson) Mitt., *J. Proc. Linn. Soc., Bot.* 4: 81 (1860). T: Fall of Waitangi, Bay of Islands, [New Zealand], *J.D.Hooker 367*; syn: BM; Wairapa Valley, [New Zealand], *W.Colenso 825*; syn: BM.

Bartramia remotifolia Hook.f. & Wilson, *in* J.D.Hooker, *Fl. Tasman.* 2: 193, t. CLXXIV, fig. 3 (1859); *Philonotis remotifolia* (Hook.f. & Wilson) A.Jaeger, *Ber. Tätigk. St. Gallischen Naturwiss. Ges.* 1873–74: 83 (1875). T: Gullies Rd, Browns R., Tas., *A.F.Oldfield 36*; syn: BM; Elliot Rivulet, near Cumming’s Head, Western Mtns, Tas., *W.Archer*; syn: *n.v.*

Bartramia catenatula Hampe, *Linnaea* 30: 631 (1860); *Philonotis catenatula* (Hampe) Paris, *Index. Bryol.* 919 (1896). T: “n alp. mont. Cobboras, 6000’”, [Vic.], *F.Mueller 142*; holo: BM.

Bartramia glaucescens Müll.Hal., *Genera Musc. Frond.* 334 (1901), *nom. nud.*, *non Bartramia glaucescens* Hornsch.; *Philonotis glaucescens* Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 155 (1906),
nom. nud., *non Philonotis glaucescens* (Hornsch.) Broth. Based on: Upper Owens R., [Vic.], syn: *n.v.*; “Pyers” [Tyers] R., Gippsland, [Vic.], syn: *n.v.*; Genoa R., [Vic.], *coll. unknown 238*, syn: NSW (NSW 416300).

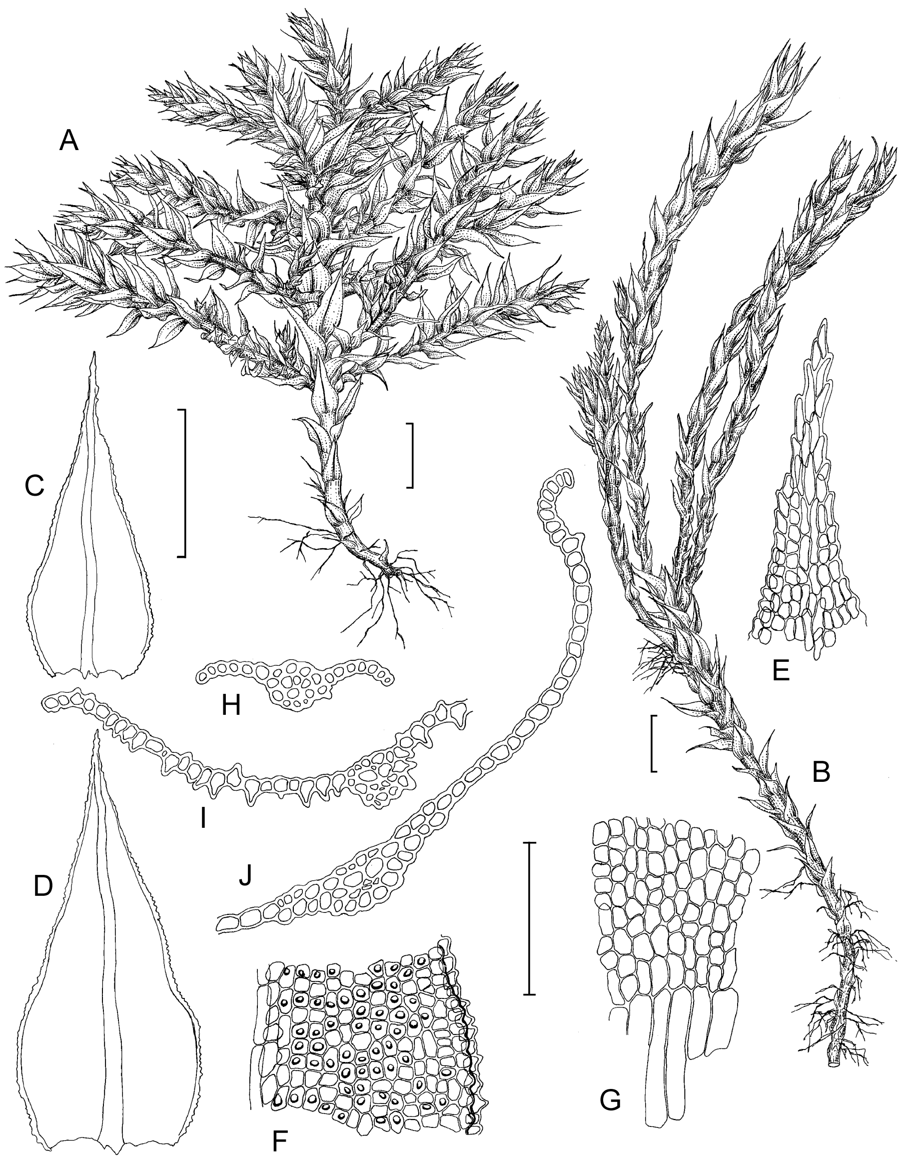

Figure 35. *Philonotis scabrifolia*. **A**, **B**, Habit; **C**, **D**, Stem leaves; **E**, Cells of leaf apex; **F**, Mid-laminal cells, each with a single median papilla; **G**, Cells of leaf base; **H–J**, Leaf sections. Scale bars: 1 mm for plants and leaves; 100 µm for cells and sections. Drawn by R.D.Seppelt. Reproduced from *The Moss Flora of Macquarie Island* 77 (2004).

Illustrations: D.G.Catcheside, *Mosses of South Australia* 290, fig. 174 (1980); D.Meagher & B.Fuhrer, *Field Guide to the Mosses and Allied Plants of Southern Australia* 115 (2003); R.D.Seppelt, *The Moss Flora of Macquarie Island* 77, fig. 30 (2004).

Plants tufted, white to glaucous green. Stems with subfloral innovations or sparingly branched, c. 20 mm tall. Leaves imbricate, wide-spreading, lanceolate to ovate-lanceolate; apex acuminate and commonly incurled; stem leaves 0.7–1.3 mm long, 0.36–0.97 mm wide; branch leaves smaller, 0.36–0.75 mm long, 0.15–0.36 mm wide; margin slightly recurved towards the apex, papillose; costa excurrent; laminal cells ±uniform, short-rectangular to subquadrate, with a large central papillae, 10–26 × 8–10 µm. Setae 15–20 mm long. Capsules usually horizontal, ovoid, sulcate, ±arcuate; operculum convex, umbonate. Peristome double. Spores reniform, papillose, 30–34 × 22–26 µm diam. Fig. 35, Plate 35.

Occurs in S.A., N.S.W., A.C.T., Vic. and Tas.; uncommon in moist, shaded habitats, on soil or, occasionally, on rock. It has also been reported for W.A., but no specimens were examined to confirm this; also in New Zealand, South America and southern Africa. Map 148.

S.A.: Hindmarsh Valley Falls, Southern Lofty Ra., *D.G.Catcheside 53.265* (AD). N.S.W.: Murphys Track, Dora Dora State Forest, 18 km SE of Holbrook, *H.Streimann 43152* (CANB); Mongo, 20 km SE of Braidwood, *H.Streimann 5133* (CANB). A.C.T.: Molonglo Gorge, 15 km E of Canberra, *H.Streimann 1833* (CANB). Vic.: Bogong High Plains road, 31 km NW of Omeo, *H.Streimann 50627* (CANB). Tas.: Myrtle Gully, Collinsvale, *A.V.Ratkowsky B425* (CANB).

This is the most distinctive Australian species of *Philonotis* due to its white to glaucous green colour and the subquadrate laminal cells with central papillae. Scott & Stone (1976) assumed that *P. glaucescens* (Hornsch.) Broth. was conspecific with *P. scabrifolia*, but they did not examine any specimens. In fact, the American *P. glaucescens* is a distinct species which Scott and Stone confused with the *nomen nudum P. glaucescens* Watts & Whitel.

6. Philonotis slateri (Hampe) A.Jaeger, *Ber. Tätigk. St. Gallischen Naturwiss. Ges.* 1877–78: 437 (1879)

Bartramia slateri Hampe, *Linnaea* 40: 306 (1876). T: banks of Brisbane R., Qld, *Slater*; syn: *n.v*.

Bartramia tortifolia Müll.Hal., *Genera. Musc. Frond.* 339 (1901), *nom. illeg.*; *Philonotis tortifolia* Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 157 (1906). T: Richmond R., N.S.W., Herb. C.Mueller 1882; syn: BM; Federal-Mullumbimby, N.S.W., *W.W.Watts 2121*; isosyn: NSW; Marshalls Falls, Richmond R., N.S.W., *W.W.Watts 1114*; isosyn: NSW; Alstonville Cutting, Richmond R., N.S.W., *W.W.Watts 1010*; isosyn: NSW; Bagnlow road, Richmond R., N.S.W., *W.W.Watts 2023*; isosyn: NSW.

Plants sparingly to densely tufted. Stems simple or sparingly branched or with subfloral innovations, to 40 mm tall. Leaves widely spaced on stem, erect-spreading to wide-spreading, narrowly lanceolate to narrowly triangular-lanceolate, with a strongly acuminate apex, 1.0–1.7 mm long, 0.1–0.3 mm wide; margin ±reflexed, denticulate-papillose to serrulate; costa usually long-excurrent, denticulate-papillose; basal laminal cells rectangular (rarely hexagonal), ±papillose, 18–48 × 8–14 µm; outer basal cells short-rectangular to subquadrate, 7–16 × 7–10 µm; median and apical cells narrower and more elongate, papillose by projecting cell ends, 22–76 × 3–10 µm. Setae to 30 mm long. Capsules horizontal to cernuous, short-cylindrical, ±arcuate, sulcate; operculum convex or sharply conical, with or without an umbo. Peristome double. Spores ovoid, globose or reniform, papillose, 21–24 µm diam.

This endemic species grows on soil in south-eastern Qld and north-eastern N.S.W. Map 149.

Qld: near Murrwillumbah, *W.Forsyth 717* & *s.n.* (NSW). N.S.W.: Tintenbar Brooklet, Richmond R., *W.W.Watts 308* (NSW); Alstonville Cutting, 5 miles [c. 8 km] from Ballina, *W.W.Watts 5047* (NSW).

Philonotis slateri is characterised by its narrow, widely spaced leaves, each with a long-excurrent costa.

7. Philonotis tenuis (Taylor) Reichardt, *Reise Novara, Pilze, Leber-Laubm.* 1(3): 178 (1870)

Bartramia tenuis Taylor, *Phytologist* 1: 1095 (1844). T: Norfolk Is., *A.Cunningham*; holo: BM (5 slides at CANB).

Bartramia fertilis Mitt., *Hooker's J. Bot. Kew Gard. Misc.* 8: 260 (1856); *Philonotis fertilis* (Mitt.) Mitt., *Trans. & Proc. Roy. Soc. Victoria* 19: 69 (1882). T: Bogong Range, Vic., *F.Mueller 112* syn: NY? *n.v.*; Australian Alps, 1855, *F.Mueller 133*, syn: NY *n.v.*

?*Bartramia pseudomollis* Müll.Hal., *Linnaea* 37: 150 (1872); *Philonotis pseudomollis* (Müll.Hal.) A.Jaeger, *Ber. Tätigk. St. Gallischen Naturwiss. Ges.* 1873–74: 82 (1875). T: Brisbane R., Qld, 1864, *A.Dietrich*; holo: *n.v.*

Bartramia dicranellacea Müll.Hal., *Genera. Musc. Frond.* 342 (1901); *Philonotis dicranellacea* (Müll.Hal.) Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 155 (1906). T: Lavender Bay, Sydney, N.S.W., Oct. 1884, *T.Whitelegge 143*; iso: NSW.

Philonotis austrofalcata Broth. & Watts, *Proc. Linn. Soc. New South Wales* 37: 373 (1912). T: Yarrangobilly Caves, N.S.W., *W.W.Watts 8702*, *8854*; syn: NSW.

Philonotis rigens Broth., *Pap. & Proc. Roy. Soc. Tasmania* 1913: 195 (1914). T: near Sorell, Tas., *coll. unknown*; holo: H-BR *n.v.*

Illustrations: G.A.M.Scott & I.G.Stone, *The Mosses of Southern Australia* 339, pl. 63 (1976); H.Streimann, *The Mosses of Norfolk Island* 8, fig. 2 (2002); R.D.Seppelt, *The Moss Flora of Macquarie Island* 79, fig. 31 (2004).

Plants densely tufted. Stems 5–35 mm tall, simple or with subfloral innovations. Leaves imbricate to well spaced on stem, erect to wide-spreading, rarely slightly falcate-secund, triangular-lanceolate to ovate-lanceolate, acute to acuminate, 0.7–1.5 mm long, 0.2–0.5 mm wide; margin reflexed, singly or doubly denticulate-papillose to serrate; costa percurrent to excurrent, denticulate-papillose; basal laminal cells rectangular (to long-hexagonal), smooth or with apical papillae, 16–50 (–80) × 8–20 µm; outer basal cells short-rectangular to subquadrate, 10–16 × 10–12 µm; median and upper cells narrower and usually longer, papillose at apex, 26–62 × 4–10 µm. Setae c. 20 mm long. Capsules horizontal to cernuous (rarely erect), sub-globose to short-cylindrical (rarely urceolate), ±slightly arcuate, sulcate; operculum convex. Peristome double. Spores ovoid, globose or reniform, markedly papillose, 18–26 µm. Plate 34.

A common species on rock and soil in all States and Territories; also in Lord Howe Is., Norfolk Is., New Zealand and Africa. Map 150.

W.A.: c. 5 miles [c. 8 km] S of Nannup, *D.H.Norris 25889* (CANB). N.T.: Chewings Ra., *P.K.Latz 7129B* (CANB). S.A.: Gran-Gran Caves, near Millicent, *L.D.Williams 3373* (CANB). Qld: Broken R., Eungella Natl Park, *H.Streimann 64170* (CANB). N.S.W.: Wardell Ferry, Richmond R., *W.W.Watts 5605* (NSW). A.C.T.: Murrumbidgee R., below Kambah Pool, *D.G.Catcheside 64.89* (CANB). Vic.: Ershore R., *W.W.Watts 1057* (NSW). Tas.: Mt Wellington, *W.A Weymouth s.n.* (CANB).

Leaves of *P. tenuis* vary from broadly triangular-lanceolate with a percurrent costa and highly reflexed margins to narrowly lanceolate with an excurrent costa and only slightly reflexed margins.

H.N.Dixon (*Proc. Roy. Soc. Queensland* 53: 32, 1942) stated that *P. pseudomollis* was “very doubtfully distinct from *P. tenuis*”. I have not had the opportunity to see the type of *P. pseudomollis*, but from other named specimens it appears to fall within the range of variability of *P. tenuis*, being a more narrow-leaved form of this highly variable species.

Doubtful Names

Philonotis longiseta (Michx.) Britton, *Bryologist* 14: 44 (1911)

Reported by Scott & Stone (*The Mosses of Southern Australia* 340, 1976) without a locality. The record cannot be verified.

Philonotis fontanoides Broth. & Watts, *Proc. Linn. Soc. New South Wales* 37: 374 (1912), *nom. illeg.* (later homonym)

T: Swamp, Kiandra Rd, about 48 miles [c. 78 km] from Tumut, N.S.W., *W.W.Watts 8873*, *8879*; *n.v.*

This is likely to fall into synonymy with one of the foregoing species.

Philonotis subluteola Müll.Hal., *Enum. Bryin. Exot.* 93 (1889), *nom. nud.*

Original collection not known.

This is probably a species of *Breutelia*.

ORTHODONTIACEAE

A. Jonathan Shaw[1]

Orthodontiaceae (Broth.) Goffinet, *in* W.R.Buck & B.Goffinet, *Bryophyte Biology* 104 (2000).

Bryaceae subfam. Orthodontoideae Broth., *Nat. Pflanzenfam.*, 2nd edn, 11: 347 (1925).

Type: *Orthodontium* Schwägr.

Autoicous, synoicous, heteroicous or paroicous. Rhizoids smooth, reddish. Leaves linear-lanceolate, flexuose, unbordered; costa narrow; laminal cells ±linear except near base. Setae slender flexuose. Capsules erect or inclined, ovoid to cylindrical with a tapering neck. Peristome double; segments narrow, finely papillose or smooth.

Goffinet raised the subfamily of Brotherus (1925) to familial status (Buck & Goffinet, 2000) based on molecular and morphological studies. The family is cosmopolitan and comprises two genera, *Orthodontium* and *Orthodontiopsis*. Only *Orthodontium*, with two species, occurs in Australia.

V.F.Brotherus, *Nat. Pflanzenfam.*, 2nd edn, 11: 347 (1925); W.R.Buck & B.Goffinet, Morphology and classification of mosses, *in* A.J.Shaw & B.Goffinet (eds), *Bryophyte Biology*, 71–123. Cambridge University Press, Cambridge.

ORTHODONTIUM

Orthodontium Schwägr., *Sp. Musc. Frond.*, Suppl. 2, 2: 123 (1827); from the Greek *ortho-* (erect) and *odontos* (a tooth), in reference to the erect peristome teeth.

Type: *O. lineare* Schwägr.

Apalodium Mitt., *Musc. Austr.-Amer*. 238 (1869). T: *O. pellucens* (Hook.) Mitt.

Stableria (Lindb.) Lindb. ex Braithw., *Brit. Moss Fl.* 2: 140 (1890). T: *S. gracilis* (Bruch, Schimp. & W.Gümbel) Lindb. ex Braithw.

Paroicous or autoicous. Plants minute to small, to 5 mm long, dull or somewhat glossy, erect, often forming dense turfs. Stems unbranched or forked. Rhizoids smooth, reddish. Leaves erect-spreading to spreading, sometimes somewhat secund, linear-setaceous, linear-lanceolate or narrowly lanceolate; margin serrulate near the apex, lacking a border; costa single, ending below or in the apex; upper median laminal cells elongate-hexagonal to rhomboidal, with thin or firm walls. Gemmae not produced. Perigonia small and bud-like, often tinged with red, on short branches (in autoicous species) below the perichaetia, numerous; perigonial leaves short-acuminate from an ovate base. Perichaetia terminal on main stems, sometimes also on short lateral branches; perichaetial leaves scarcely differentiated (leaves gradually longer toward the top of the plant). Setae erect. Capsules erect, short- to long-cylindrical, less commonly pyriform or almost urceolate, with a small and inconspicuous or ±elongate sterile neck, sometimes sulcate when dry; exothecial cells of the urn rectangular, ±abruptly and conspicuously smaller and very thick-walled near the capsule mouth; annulus poorly developed, in 1 or 2 rows, separating irregularly; operculum conical to oblique-rostrate. Peristome usually double, rudimentary to well developed; peristomial formula typically 4: 2: 4; exostome teeth smooth to ±papillose (especially near the apex), bluntly narrow-triangular, rarely rudimentary and irregular, typically hyaline; endostome hyaline, smooth or sometimes papillose above, sometimes rudimentary and adhering to the exostome teeth; basal membrane absent or ±well developed and up to 25–33% the height of the exostome teeth; segments narrow, scarcely

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tapered to the apex, scarcely keeled and not perforate, in some species rudimentary or absent; cilia absent. Spores small to rather large, ±smooth to coarsely roughened.

A almost cosmopolitan genus of 7–10 species, primarily in tropical and southern-temperate regions; two species occur in Australia.

Orthodontium can be recognised by the narrow, setaceous to linear-lanceolate leaves and erect capsules with variously reduced peristome teeth. In Australian plants, the exostome teeth can be shorter than the well-developed endostome segments (*O. lineare*), or the endostome is rudimentary and adhering to the inner surface of the teeth (*O. pallens*). Australian specimens are generally autoicous, but perigonia are sometimes difficult to find, and some dioicous plants may occur.

W.D.Margadant & W.Meijer, Preliminary remarks on *Orthodontium* in Europe, *Trans. Brit. Bryol. Soc.* 1: 266–274 (1949); W.Meijer, The genus *Orthodontium*, *Acta Bot. Neerl.* 1: 1–80 (1952); L.Hedenäs, T.Herben, H.Rydin & L.Söderström, Ecology of the invading moss species, *Orthodontium lineare* in Sweden: spatial distribution and population structure, *Holarctic Ecol.* 12: 163–172 (1989).

Plants small to medium-sized; setae (10–) 20–35 mm long; endostome segments well developed, as long as or longer than the exostome...**1. O. lineare**

Plants minute; setae 5–15 mm long; endostome rudimentary, forming an irregular membrane ±adhering to the exostome teeth; segments absent, rarely linear, delicate and irregular ....**2. O. pallens**

1. Orthodontium lineare Schwägr., *Sp. Musc. Frond.*, Suppl. 2, 2: 124 (1827)

Apalodium lineare (Schwägr.) Mitt., *Pap. Sci. Res. Voy. Challenger, Bot.* 1(3): 198 (1885). T: Cape of Good Hope, South Africa, *A.Menzies s.n.*; holo: G, *n.v. fide* W.Meijer, *Acta Bot. Neerl.* 1: 27 (1952).

Orthodontium australe Hook.f. & Wilson, *London J. Bot.* 3: 545 (1844). T: Falkland Is., *J.D.Hooker s.n.*; holo: BM.

Orthodontium sulcatum Hook.f. & Wilson, *in* W.J.Hooker, *Icon. Pl.* 8: pl. 739B (1845); *Apalodium sulcatum* (Hook.f. & Wilson) Mitt., *Trans. & Proc. Roy. Soc. Victoria* 19: 65 (1882); *O. lineare* subsp. *sulcatum* (Hook.f. & Wilson) Meijer, *Acta Bot. Neerl.* 1: 34 (1952). T: W.A., *J.Drummond s.n.*; holo: BM.

Orthodontium lanceolatum Mitt., *Hooker's J. Bot. Kew Gard. Misc.* 8: 261 (1856); *Apalodium lanceolatum* (Mitt.) Mitt., *Trans. & Proc. Roy. Soc. Victoria* 19: 65 (1882). T: Mt Wellington, Tas., *F.Mueller 61*; holo: NY.

Orthodontium robustiusculum Müll.Hal., *Hedwigia* 37: 85 (1895); *O. australe* subsp. *robustiusculum* (Müll.Hal.) Meijer, *Acta Bot. Neerl.* 1: 40 (1952). T: Tas., 1889, *W.A.Weymouth s.n.*; iso: NSW.

Orthodontium zetterstedtii Müll.Hal., *Hedwigia* 37: 85 (1898). T: N.S.W and Vic.; collections by *D.Sullivan, T.Whitelegge* and *J.E.Zetterstedt*; iso: MEL; Woollabra [Woollahra], Sydney, [N.S.W.] 1884, *T.Whitelegge*.

Illustrations: W.Meijer, *Acta Bot. Neerl.* 1: 31, 33, 35–37, 43, figs 6–10 (1952).

Autoicous or rarely paroicous, or apparently dioicous. Plants small to medium-sized, dull to ±glossy. Leaves linear-setaceous to linear-lanceolate, occasionally more broadly lanceolate, sometimes slightly secund, serrulate to subentire near the apex; upper laminal cells elongate-hexagonal to long-rhomboidal, 75–190 × 7–17 µm, with thin to firm or sometimes thickened walls; basal cells lax and thin-walled to inflated. Setae (10–) 20–35 mm long. Capsules erect, typically cylindrical, more rarely ovate-cylindrical or narrowly pyriform, to c. 4.5 mm long, often ±sulcate. Peristome double, well developed; exostome teeth tapered from base to apex, 150–375 µm long, blunt or ±narrowly acute, hyaline, smooth or ±papillose near the apex; endostome hyaline; basal membrane scarcely exceeding the capsule rim or up to one-third the height of the exostome teeth; segments well-developed, 130–325 µm long, smooth or ±papillose near the apex. Spores 13–19 µm, finely roughened. $n = 22$, *fide* H.P.Ramsay, *Austral. J. Bot.* 22: 312 (1974).

Widely distributed and rather common in W.A., S.A. N.S.W., A.C.T., Vic. and Tas.; grows on rotting or burned wood. Also known from South America, southern Africa, and New Zealand. Map 151.

W.A.: Torbay Hill Rd, *G.Bell 391* (AD). S.A.: Clarendon, *O.Tepper 640* (MEL). N.S.W.: La Perouse, *W.Forsyth 3960* (NSW). A.C.T.: Tidbinbilla, *D.G.Catcheside 75.58* (AD). Vic.: 5 km SW of Bendoc, *H.Streimann 43676* (CANB). Tas.: Mt Wellington, *R.A.Bastow 287* (MEL).

This moss is extremely variable in almost all features, but the peristome is comparatively well developed compared to *O. pallens*.

There are no distinguishing features to separate *O. lineare*, *O. australe* and *O. sulcatum*. Variation in plant size, leaf shape, capsule form (sulcate or not) and peristome development seems to occur independently, such that these taxa cannot be separated by any recurring suite of characters.

Orthodontium lineare was first collected in England in 1911–12 and is now fairly common in many areas of western Europe and southern Scandinavia. It provides one of the most thoroughly studied cases of a weedy moss whose range has greatly expanded during recent times.

2. **Orthodontium pallens** (Hook.f. & Wilson) Broth., *Nat. Pflanzenfam*. I, 3: 544 (1903)

Weissia pallens Hook.f. & Wilson, *in* J.D.Hooker, *Icon. Pl. Rar.* 8: pl. 739A (1845). T: W.A., *J.Drummond s.n*.; holo: BM.

Apalodium inflatum Mitt., *Rep. Sci. Res. Voy. Challenger, Bot.* 1(3): 198 (1885). T: N.S.W., *Rev. R.Collie s.n*.; holo: NY.

Orthodontium ovale Müll.Hal. ex Broth., *Oefvers. Förh. Finsk. Vetensk.-Soc.* 35: 47 (1893). T: Gosford, N.S.W., *T.Whitelegge 445*; holo: H.

Apalodium lineare Mitt., *Trans. & Proc. Roy. Soc. Victoria* 19: 65 (1882), *nom. illeg., incl. spec. prior.* (*Weissia pallens* Hook.f. & Wilson, 1845).

Illustration: W.Meijer, *Acta Bot. Neerl.* 1: 44, fig. 11 (1952).

Autoicous. Plants minute to small, to 5 mm, usually dull. Leaves linear-setaceous to linear-lanceolate, sometimes slightly secund, serrulate to subentire near the apex; upper laminal cells elongate-hexagonal to long-rhomboidal, 35–75 × 4–10 µm, with thin to firm walls; basal cells thin-walled, tending to collapse. Setae (4–) 8–15 mm long. Capsules erect, short-cylindrical or broadly pyriform, rarely almost urceolate, to c. 2.5 mm long, not sulcate. Peristome poorly developed, appearing single although exostome and endostome are usually present; exostome teeth rather short or rudimentary, generally blunt, 65–140 µm long, hyaline, smooth or nearly so; endostome rudimentary, hyaline, usually not forming well-differentiated segments, consisting of an irregular membrane adhering to the inner exostomial surface; segments occasional, slender, smooth, irregular. Spores (15–) 18–30 µm, rather coarsely roughened. Chromosome number not known.

Rare in W.A., N.S.W., A.C.T. and Vic.; grows on burned or rotting wood, sometimes mixed with *O. lineare*. Possibly endemic to Australia, but the species is poorly known. Map 152.

W.A.: Beedelup Falls, *W.Weber B33577* (CANB); Darling Bow R., 1913, *Jackson s.n.* (NSW). N.S.W.: near Point Hicks, *H.Streimann 39667* (CANB). A.C.T.: Tidbinbilla, *H.Streimann 1423* (CANB). Vic.: Cabbage Tree Ck Flora Reserve, *H.Streimann 43801* (CANB).

This species is characterised by the very small gametophyte and sporophyte and the narrowly to broadly ovate capsules with a markedly reduced peristome. The capsules of *O. pallens* are not sulcate as in most forms of *O. lineare*; they are also smaller. The endostome appears to be absent, but consists of a transparent membrane that adheres to the exostome. It either tears between the exostome teeth or is only formed adjacent to the teeth; no separate basal membrane is visible.

This species can be difficult to distinguish from very small forms of *O. lineare*, especially when fresh capsules with mature peristomes are not available. *Orthodontium pallens* is far less common, and the relationship between the two species required further study. Occasional specimens [e.g. *Watts 1087* (NSW); *Catcheside 72.176* (AD), duplicate at NSW] that agree in size and capsule shape with *O. pallens* have a few well-formed endostome segments (i.e. a single capsule might have one long segment with the remaining segments rudimentary).

BRYACEAE

John R. Spence[1] *& Helen P. Ramsay*[2]

Bryaceae Schwägr., *in* C.L. von Willdenow, *Sp. Pl.* 5(2): 47 (1830).

Type: *Bryum* Hedw.

Dioicous, synoicous or, rarely, autoicous. Plants mostly tufted, usually green or yellowish, sometimes with pink or red colouration. Stems erect, sometimes arising from stoloniferous primary stems (*Rhodobryum*), simple or branched by subperichaetial innovations, sometimes radiculose below with coloured papillose rhizoids. Leaves in many rows, usually small and remote below, larger and crowded above, frequently in comal tufts or rosulate, usually erect to erect-spreading, rarely complanate, sometimes twisted or crisped when dry, lanceolate to ovate, rarely triangular, obovate or spathulate, mostly acute, sometimes long-acuminate or piliferous, frequently bordered, unistratose; border rarely bistratose; margin smooth or denticulate to serrate; costa single, well developed, often excurrent, sometimes with a stereid band in cross-section. Laminal cells smooth, prosenchymatous, typically transparent, relatively large; upper cells rhomboidal-hexagonal to rhomboidal or, less frequently, linear or vermicular, rectangular or sometimes short-rectangular or quadrate towards base. Gemmae frequently produced. Perichaetia and perigonia mostly terminal; perichaetia rarely on short basal branches; perichaetial leaves not well differentiated. Calyptra cucullate, smooth, usually shed early in capsule development. Setae elongate, usually solitary, rarely multiple, erect or ±curved near tip. Capsules mostly inclined to pendent or nutant, occasionally curved, rarely erect, usually symmetrical, almost always smooth, ovoid, pyriform or oblong-cylindrical, rarely subglobose, with a well-developed neck tapered to the seta and wrinkled when dry; annulus usually present, large and revolute; operculum convex to short-conical, umbonate or apiculate, rarely short-rostrate; stomata numerous, restricted to neck, mostly superficial. Peristome usually present, diplolepidous, double, rarely single; exostome teeth 16, mostly lanceolate and slender-pointed, often bordered, prominently trabeculate, papillose on the outer surface; endostome segments typically 16, alternating with teeth, hyaline or yellow, keeled, arising from a generally well-developed smooth basal membrane; cilia delicate, 1–3. Spores smooth to finely papillose, 8–50 µm diam. n = 10, 11 (10 + m), 20, 30 for Australian species, *fide* H.P.Ramsay & J.R.Spence, *J. Hattori Bot. Lab.* 80: 151–170 (1996); see also R.Fritsch, *Bryophyt. Biblioth.* 40: 1–352 (1991).

The cosmopolitan Bryaceae comprises 15 genera and up to 600 species and is found in most habitats, from running streams to dry deserts and from the polar regions to tropical latitudes. It is most common in open situations, less so in dense forest. Species usually grow on earth, rock or rotting wood, less commonly as an epiphyte. The family is represented in Australia by eight genera and 54 species.

The family traditionally consisted of four subfamilies — Orthodontoideae, Mielichhoferioideae, Pohlioideae and Bryoideae. This classification placed particular emphasis on the sporophyte, especially the position of the gametangia, capsule orientation, and reduction in the peristome. Recent and current studies are redrawing subfamily relationships more along gametophytic lines (Cox & Hedderson, 2003; Pederson *et al.*, 2003). Peristome reduction appears to have occurred independently several times, and is probably not the best indicator of phylogenetic affinities. Most problems lie in the large polyphyletic genera *Bryum* and *Brachymenium* which require a re-assessment of generic and subfamily limits. *Pohlia*, *Mniobryum* and *Schizymenium* apparently share a more recent ancestor with *Mnium* (Mniaceae) and related genera than with genera in the Bryaceae subfam. Bryoideae.

[1] Glen Canyon National Recreation Area, 691 Scenic View Drive, P.O. Box 1507, Page, Arizona 86040-1507, United States of America.

[2] c/- National Herbarium of New South Wales, Royal Botanic Gardens and Domain, Mrs Macquaries Road, Sydney, New South Wales 2000.

Leptobryum belongs in the Meesiaceae with other genera having a well-developed, sterile capsule neck. *Orthodontium*, long enigmatic within the Bryaceae (and placed in its own subfamily by Brotherus), is positioned by molecular investigations in the resurrected family Orthodontiaceae (Buck & Goffinet, 2000). The inclusion of *Pleurophascum* in the family (Buck & Goffinet, 2002) was due to misreading the rps4 in the matrix, and it has now has been excluded and returned to its own family Pleurophascaceae (Goffinet & Buck, 2004). The Bryaceae *s. str.* thus includes mostly genera with heterogenous laminal areolation and comparatively short cells and typically bordered leaves (subfam. Bryoideae *sensu* Brotherus).

Earlier studies of Australian Bryacaeae (Ochi, 1970, 1972, 1973, 1984, 1988) were based entirely on herbarium specimens, while more recent investigations (Spence, 1996, 2005; Spence & Ramsay, 1996, 1999, 2005) have also benefited from extensive field studies by J.R.Spence. This treatment represents the first major revision in more than 100 years. Groups of species are described based primarily on features of the gametophyte, which appears to provide a relatively stable basis for delimitation of genera in the Bryaceae. A new genus *Rosulabryum* was described for the rosulate species (Spence, 1996). New concepts are included here for *Brachymenium*, and *Bryum* has been restricted to those species formerly placed in *Anomobryum* (Spence & Ramsay, 2002). The genus *Ptychostomum* has been resurrected for species previously placed in *Bryum* section *Cladodium* (Spence, 2005). Two new genera, *Ochiobryum* and *Gemmabryum*, have also been described (Spence & Ramsay, 2005).

The Bryaceae are best characterised by the capsule shape: elongate with a well-formed neck that tapers to the seta. The capsules are mostly pyriform and nodding. The perfect double peristome with alternating exostome and endostome is variously reduced in a few genera. It resembles that of the Mniaceae and Aulacomniaceae as well as hypnoid pleurocarps. Chromosome numbers are based on x =10 (perhaps 5) with considerable intra- and interspecific polyploidy and aneuploidy.

In the absence of sporophytes, some members of the Bryaceae are notoriously difficult to identify to species or even genus. However, details of laminal areolation can often place a specimen in the appropriate genus or section reasonably quickly. Most species conform to one of three basic patterns of areolation in older leaves as follows:

a. **Pohlioid:** with laminal cells elongate and linear to hexagonal and ±uniform from near the leaf tip to the base, e.g. *Ochiobryum* and *Plagiobryum*.

b. **Rhodobryoid:** with upper laminal cells rhomboidal to hexagonal, gradually changing to more elongate and rectangular in the lower part of the leaf, e.g. *Brachymenium*, *Ptychostomum*, *Rhodobryum* and *Rosulabryum*.

c. **Anomobryoid:** in which the upper laminal cells are elongate and linear to hexagonal, with the lower cells abruptly quadrate to short-rectangular and often broader, e.g. *Bryum* and *Gemmabryum*.

In addition to these laminal cell patterns, vegetative propagules such as filamentous gemmae, bulbils, rhizoidal tubers and stem tubers can facilitate identification, especially of sterile collections. It is important to look at *older* leaves when using a key as the current year’s growth and sterile innovations often produce atypical leaves.

H.Ochi, A revision of the subfamily Bryoideae in Australia, Tasmania, New Zealand and adjacent islands, *J. Fac. Educ. Tottori Univ. Nat. Sci*. 21: 7–67 (1970); H.Ochi, Some problems of distributional patterns and speciation in the regions including Eurasia, Africa and Oceania, *J. Hattori Bot. Lab*. 35: 217–223 (1972); H.Ochi, Supplement to the subfamily Bryoideae (Musci) in Australia and New Zealand, *Hikobia* 6: 217–223 (1973); G.A.M.Scott & I.G.Stone, *The Mosses of Southern Australia* 269–303 (1976); D.G.Catcheside, *Mosses of South Australia* 248–278 (1980); H.Streimann & A.Touw, New records for some Australian mosses, *J. Hattori Bot. Lab*. 49: 261–271 (1981); H.Ochi, A phytogeographical consideration of Australasian Bryoideae in relation to those in other continents, *J. Hattori Bot. Lab*. 52: 65–73 (1982); I.G.Stone, Some new and noteworthy records of mosses mostly from Queensland, Australia, *Austrobaileya* 1: 511–520 (1982); H.Ochi, An annotated list of mosses of the subfamily Bryoideae in South, Southeast and East Asia, *J. Fac. Educ. Tottori Univ. Nat. Sci*. 34(2): 41–96 (1985); J.R.Spence, A proposed reclassification of *Bryum*, *Anomobryum*

and *Brachymenium* (Musci, Bryaceae), *J. Bryol*. 14: 659–676 (1987); H.Ochi & H.Streimann, Miscellaneous additions of bryaceous mosses (Bryaceae) to the floras of Papua New Guinea and Australia, *Mem. New York Bot. Gard.* 45: 615–617 (1987); H.Ochi, Recent work on a worldwide revision of the Bryoideae (Musci), *Bryol. Times* 48: 1–3 (1988); H.Ochi, A revised infrageneric classification of the genus *Bryum* and related genera (Bryaceae, Musci), *Bryobrothera* 1: 231–244 (1992); H.P.Ramsay & J.Seur, *Type Specimens of Mosses in Australian Herbaria*. Flora of Australia Supplementary Series No. 2. Australian Biological Resources Study, Canberra (1994); J.R.Spence & H.P.Ramsay, Biogeography of the subfamily Bryoideae (Bryaceae, Musci) in north-eastern Queensland, *Austral. Syst. Bot*. 9: 185–192 (1996); H.P.Ramsay & J.R.Spence, New chromosome data on Australasian Bryaceae, *J. Hattori Bot. Lab*. 80: 151–170 (1996); J.R.Spence & H.P.Ramsay, New and interesting species of Bryaceae from Australia, *J. Adelaide Bot. Gard*. 17: 107–118 (1996); W.R.Buck & B.Goffinet, Morphology and classification and mosses, *in* J.Shaw & B.Goffinet (eds), *Bryophyte Biology* 71–123 (2000); C.J.Cox & T.A.J.Hedderson, Phylogenetic relationships within the moss family Bryaceae based on chloroplast DNA evidence, *J. Bryol*. 25: 31–40 (2003); N.Pedersen, C.J.Cox & L.Hedenäs, Phylogeny of the moss family Bryaceae inferred from chloroplast DNA sequences and morphology, *Syst. Bot*. 28: 471–482 (2003); J.R.Spence, A preliminary treatment of the Bryaceae of the Bryophyte Flora of North America region, *Evansia* 21: 1–16 (2004); B.Goffinet & W.R.Buck, Systematics of the Bryophyta (mosses). From molecules to a revised classification, 205–239, *in* B.Goffinet, V.Hollowell & R.Magill (eds), *Molecular Systematics of Bryophytes.* Missouri Botanical Garden Press, St. Louis (2004); J.R.Spence, New genera and combinations in the Bryaceae (Bryales, Musci) for North America, *Phytologia* 87: 15–28 (2005); J.R.Spence & H.P.Ramsay, New genera and combinations in the Bryaceae (Bryales, Musci) for Australia, *Phytologia* 87: 61–71 (2005).

KEY TO GENERA

1 Laminal areolation homogeneous; cells elongate-rhomboidal to linear (> 6: 1) throughout leaf except at insertion; sporophytes sometimes appearing lateral 2

1: Laminal areolation heterogeneous; cells in lower third of leaf either longer and regularly rectangular, or abruptly shorter, becoming short-rectangular (2: 1) or quadrate and sometimes wider; sporophytes always appearing terminal 3

2 Leaves often complanate on stem, with a distinct smooth border of narrow elongate thick-walled cells *(1)* .... **4. OCHIOBRYUM**

2: Leaves not complanate, unbordered .... **5. PLAGIOBRYUM**

3 Stems gemmiform to julaceous; upper and median laminal cells elongate-rhomboidal to vermicular; cells becoming abruptly quadrate or, rarely, short-rectangular (2: 1) and broader in lower third, with transition often abrupt; leaves never obovate or spathulate with serrulate margins *(1:)* 4

3: Stems rarely gemmiform, never julaceous; upper and median laminal cells rhomboidal, becoming gradually regularly rectangular and longer below, sometimes narrower than cells above; leaves sometimes obovate or spathulate with serrulate margins 5

4 Plants strongly julaceous, small, less than 10 mm long; leaves < 1 mm long; costa weak, usually ending below apex or percurrent; cross-section of costa with a single layer of large thin-walled ventral cells; upper lamina and apiculus (if present) markedly hyaline; asexual reproduction by axillary leaf bulbils; dioicous *(3)* .... **2. BRYUM**

4: Plants small to large, with imbricate or shrunken and contorted leaves, or occasionally julaceous with imbricate leaves and often more than 10 mm long; stems bud-like; leaves mostly > 1 mm long; costa strong, in cross-section with 2 layers of large thin-walled dorsal cells; upper lamina and hairpoint coloured, rarely hyaline; asexual reproduction by rhizoidal tubers, stem tubers and axillary leaf bulbils; dioicous or synoicous .... **3. GEMMABRYUM**

5 Plants epiphytic; leaves reddish, obovate with serrulate margins; capsules erect, long-necked, globose to pyriform *(3:)* .... **1. BRACHYMENIUM**

5: Plants on decaying wood or other substrata, rarely epiphytic; leaves variously coloured, obovate, spathulate or lanceolate to ovate; margins ±smooth to serrate; capsules inclined to nutant, cylindrical to ovate, not erect or long-necked 6

6 Leaves ovate to ovate-lanceolate, usually < 3.5 mm long and with a group of inflated coloured cells at the insertion; margin smooth to weakly serrulate near apex; filiform gemmae absent *(5:)*............... .... **6. PTYCHOSTOMUM**

6: Leaves mostly obovate to spathulate, small to large (> 4 mm long); margin usually distinctly serrulate or serrate, rarely almost entire; inflated coloured cells absent; rhizoidal tubers often present; filamentous gemmae sometimes present in leaf axils...7

7 Plants large, with underground stolons; leaves often > 5 mm long, equidistant along stem; costa in cross-section with stereid band absent or greatly reduced; asexual reproductive structures absent *(6:)*.... .... **7. RHODOBRYUM**

7: Plants small to large; stolons absent; leaves mostly < 4 mm long, usually forming distinct terminal rosettes; costa with a well-developed stereid band (cross-section); filiform leaf axil gemmae and rhizoidal tubers often present ....**8. ROSULABRYUM**

1. BRACHYMENIUM

Brachymenium Schwägr., *Sp. Musc. Frond.*, Suppl. 2, 1: 131 (1824); from the Greek *brachys* (short) and *meninx* (a membrane), in reference to the low basal membrane of the endostome.

Lecto: *B. nepalense* Hook.

Autoicous. Plants medium-sized to comparatively large, in tufts on bark. Stems often branched by subfloral innovations. Leaves rosulate, contorted to spirally twisted around the stem when dry, erect to recurved when moist, obovate, spathulate or rarely ovate or lanceolate; margin recurved or plane above, denticulate to serrate in upper half; costa short- to long-excurrent, strong, in cross-section with a well-developed stereid band and 2 ventral layers of thin-walled cells; upper and middle laminal cells irregularly rhomboidal (3–5: 1); lower laminal cells longer and more regularly rectangular. Gemmae not known. Perigonial and perichaetial leaves differentiated; outer leaves larger than vegetative leaves; inner leaves smaller and acuminate. Setae long-exserted. Capsules erect, pyriform to globose, rarely cylindrical; apophysis short to elongate; operculum minutely umbonate to bluntly conical. Peristome double; exostome papillose; endostome reduced, lacking cilia; segments often lacking or fused with exostome teeth. Spores large, 25–40 µm diam., somewhat papillose to almost smooth.

Brachymenium, as it is now circumscribed, includes c. 25 species that are concentrated in montane tropical and subtropical areas of Africa, with a few species found in similar habitats in India and SE Asia. Only two species occur in New Guinea, and two reach Australia. *Brachymenium* is primarily epiphytic and is characterised by erect, pyriform to globose capsules, a strongly reduced peristome, monoicy, and large spores. The obovate, serrate leaves and *Rhodobryum*-type laminal areolation align the genus with *Rosulabryum* and *Rhodobryum*. The sporophytes, mostly autoicous in their sexuality and with spores, are distinctive. We interpret the genus in a narrow sense, including only monoicous species with erect, globose to pyriform capsules and large spores. The status of several Neotropical species, reported to be dioicous and having inclined, elongate capsules, needs to be investigated; it is possible that they are referable to *Rosulabryum*.

Brachymenium species are gametophytically similar to *Bryum*, and the genus has been traditionally characterised by its erect capsules with reduced peristomes. *Brachymenium* appears to be polyphyletic, with species representing three different genera included within it. The type species and its allies in sect. *Brachymenium* are autoicous, epiphytic species with erect, globose capsules. The other sections of the genus are only distantly related to this. Australian species of sect. *Dicranobryum* are morphologically similar to many species of *Gemmabryum*, and are characterised as small plants with imbricate, ovate or ovate-lanceolate leaves, erect or inclined capsules, and axillary leaf bulbils and rhizoidal tubers. Section *Leptostomopsis* is characterised by densely radiculose species in compact mats, with the leaves somewhat hyaline at the tip, strongly excurrent, denticulate costae and dioicous sexuality. This section represents a distinct genus and is not found in Australia (Spence, 2005).

Only three species of *Brachymenium* (*B. preissianum*, *B. acuminatum* and *B. lanceolatum*) were reported by Ochi (1970) for Australia, but more recent intensive collecting added several previously unrecorded taxa, including *B. exile*, *B. nepalense*, *B. coarctatum* and *B. indicum*. However, the revised circumscription of the genus leaves only *B. nepalense* and *B. lanceolatum*, the other taxa being transferred to *Gemmabryum*.

H.Ochi, A revision of the subfamily Bryoideae in Australia, Tasmania, New Zealand and adjacent islands, *J. Fac. Educ. Tottori Univ. Nat. Sci*. 21: 7–67 (1970); H.Ochi, A revision of African Bryoideae, Musci (first part), *J. Fac. Educ. Tottori Univ. Nat. Sci*. 23: 1–126 (1972); H.C.Gangulee, *Mosses of Eastern India and Adjacent Regions* 2: 928–952 (1974–77); H.Ochi, A revision of the neotropical Bryoideae, Musci (first part), *J. Fac. Educ. Tottori Univ. Nat. Sci*. 29: 49–154 (1980); T.Koponen & D.H.Norris, Bryophyte flora of the Huon Peninsula, Papua New Guinea XI. *Brachymenium*, *Epipterygium*, *Leptobryum*, *Mielichhoferia*, *Orthodontium* and *Pohlia* (Bryaceae), and Leptostomataceae (Musci), *Acta Bot. Fenn.* 131: 99–127 (1985); A.Eddy, *A Handbook of Malesian Mosses* 3: 165–176 (1996); J.R.Spence, New genera and combinations in Bryaceae (Bryales, Musci) for North America, *Phytologia* 87: 15–28 (2005).

Leaves lanceolate to oblong-lanceolate, irregularly contorted, yellowish brown; capsules elongate-ovate to oblong .... **1. B. lanceolatum**

Leaves obovate, or at least some leaves widest above middle, spirally contorted, often reddish; capsules globose to pyriform .... **2. B. nepalense**

1. Brachymenium lanceolatum Hook.f. & Wilson, *in* J.D.Hooker, *Fl. Tasman.* 2: 188 (1859)

Bryum lanceolatum (Hook.f. & Wilson) Mitt., *Trans. & Proc. Roy. Soc. Victoria* 19: 71 (1882). T: Tas., *R.C.Gunn s.n*.; holo: BM.

Illustration: H.Ochi, *J. Fac. Educ. Tottori Univ. Nat. Sci*. 21: 9, fig. 1 (1970).

Plants tufted, to 13 mm tall, branched by 2 or 3 innovations, yellowish with a brownish tint below, soft, not lustrous; fertile stems short. Leaves appressed to stem and contorted when dry, erect to erect-spreading when moist, yellowish brown; leaves of innovations soft, entire, lanceolate to oblong-lanceolate, to 3.4 mm long and 0.8 mm wide; apex long-acuminate; margin revolute; costa rather strong, long-excurrent with a smooth slender apex; laminal cells thin-walled, rhomboidal-hexagonal or elongate-hexagonal, 80–120 × 13–18 µm, smaller towards the apex, narrower and more elongate towards the margin, forming a distinct border of 1 or 2 rows of yellowish thicker-walled linear-vermicular cells; basal cells abruptly more lax. Setae erect, slender, ±flexuose, c. 30 mm long, red. Capsules erect, ovate to oblong with a short neck, reddish brown; operculum low-conical. Peristome: exostome teeth yellow, lanceolate, with a hyaline apex; endostome pale yellowish; basal membrane c. half the height of exostome teeth; segments and cilia irregular in length and width. Only immature spores seen. Chromosome number not known. Fig. 36G–K.

Known in Australia only from the type collection from Tas.; also in India. Map 153.

This species has not been collected in Tas. since the original description. As the only other collections come from India (described as *B. longifolium* Dixon & P. de la Varde), and given that Gunn corresponded with Hooker, it is possible that the type specimen is a mislabelled Indian collection.

2. Brachymenium nepalense Hook., *in* C.F.Schwägrichen, *Sp. Musc. Frond.*, Suppl. 2, 1: 131 (1824)

T: Nepal, *W.J.Hooker s.n*.; lecto: BM, *fide* H.Ochi, *J. Fac. Educ. Tottori Univ. Nat. Sci*. 23: 32–33 (1972).

Illustrations: H.C.Gangulee, *Mosses of Eastern India and Adjacent Regions* 2: 939, fig. 449 (1974); A.Eddy, *Handb. Malesian Mosses* 3: 167, fig. 444 (1996).

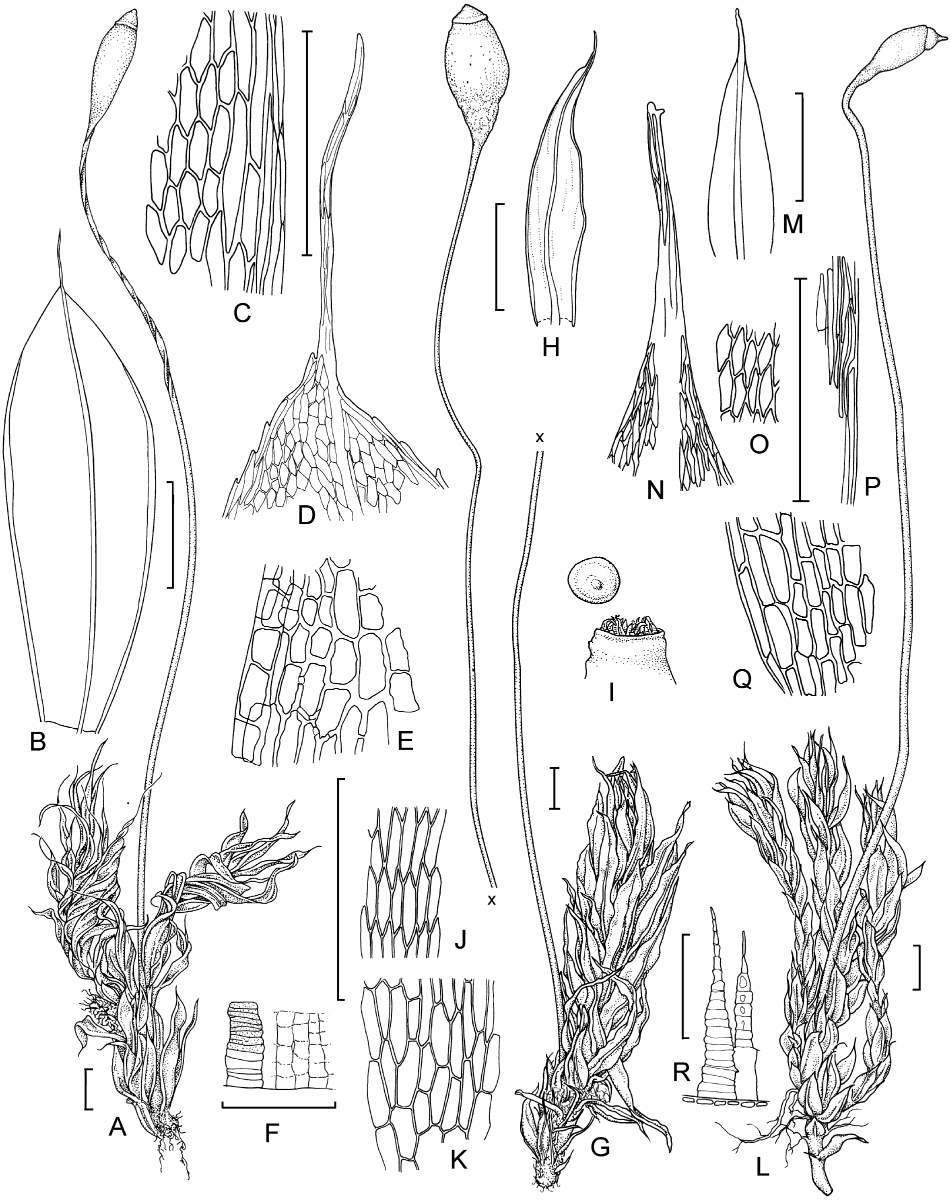


Figure 36. *Brachymenium* and *Ptychostomum*. **A–F**, *Brachymenium nepalense*. **A**, Habit with sporophyte (dry specimen); **B**, Leaf; **C**, Mid-laminal cells; **D**, Cells at leaf apex; **E**, Basal laminal cells; **F**, Peristome, with short exostome tooth (left) and endostome reduced to basal membrane only, segments absent (right) (A–F, *I.G.Stone 15718*, MEL). **G–K**, *Brachymenium lanceolatum*. **G**, Habit with sporophyte (dry specimen); **H**, Leaf; **I**, Capsule showing operculum and peristome; **J**, Mid-laminal cells; **K**, Basal laminal cells (G–K, holotype, redrawn from Ochi (1970) p. 9, fig. 1). **L–R**, *Ptychostomum altisetum*. **L**, Habit with sporophyte (dry specimen); **M**, Leaf; **N**, Cells at leaf apex; **O**, Mid-laminal cells; **P**, Marginal cells; **Q**, Basal laminal cells; **R**, Peristome (L–R, *W.B.Schofield*, NSW). Scale bars: 1 mm for habit; 0.5 mm for leaves, 100 µm for cellular drawings. Drawn by L.Elkan.

Plants tufted, 10–20 mm long, often reddish-tinged, matted with finely papillose red rhizoids below. Leaves contorted to spirally twisted around stem when dry, erect-spreading when moist, green, yellowish or reddish, obovate to spathulate, forming distinct comal tufts on fertile stems, very variable in size, usually less than 5 mm long, 1–2 mm wide; margin revolute at least below the middle, denticulate above; costa narrow, red-brown or yellowish, excurrent as a long arista or reddish hairpoint in comal leaves, sometimes percurrent; upper laminal cells rhomboidal, 30–60 × 12–18 µm, with thin porose walls; leaves strongly bordered by 2–4 rows of narrow reddish to yellowish incrassate cells; basal cells long and narrowly rectangular. Perichaetial leaves smaller, more narrowly obovate to lanceolate, with a long hairpoint. Setae erect, somewhat flexuose, 20–50 mm long, reddish. Capsules long-necked, erect to suberect, narrowly to broadly pyriform or globose, red-brown; neck tapered; operculum minutely umbonate, bluntly conical. Peristome: exostome teeth smooth at base, papillose distally, yellow to pale tan; endostome rudimentary, yellow to white, with short segments, or the segments and cilia lacking or vestigial. Spores 25–35 µm diam. Chromosome number not known. Fig. 36A–F.

Known from a few localities in montane areas of north-eastern Qld; also a widespread and highly variable corticolous species of tropical, montane forest in Asia, Malesia, New Guinea, Africa and Polynesia. Map 154.

Qld: Mt Fisher, *I.G.Stone 15718* (MEL); Maalan Ck, *H.Streimann 30592* (CANB); Barron State Forest, Herberton Ra., *H.Streimann 27217* (CANB); Thornton Peak, *J.R.Clarkson 5582* (MEL ex BRI); Mt Spec Natl Park, *I.G.Stone 24819* (MEL).

The reddish colouration is distinctive. When sterile, *B. nepalense* can only be distinguished from sterile *Rosulabryum* by its epiphytic habit and rather strongly coloured leaf border. Smaller forms resemble *Rosulabryum capillare*, the larger forms approaching *R. billarderi* in vigour. *Brachymenium nepalense* often occurs in rather small quantities mixed with other bryophytes. Australian plants are comparatively large.

Doubtful and Excluded Names

Brachymenium klotzschii (Schwägr.) Paris, *Index Bryol.* 123 (1894)

The putative Australian specimen of this Neotropical species has not been found.

Brachymenium pulchrum Hook., *Bot. Misc.* 1: 136 (1829)

A specimen located at MEL labelled “Australia coll. by Mitten ex Herbarium E.G.Britton.” is probably a mislabelled specimen of this South African species. As no other Australian collections have been located it is excluded from the Australian flora.

2. BRYUM

Bryum Hedw., *Sp. Musc. Frond.* 178 (1801); derived from the Greek *bryon* (a moss).

Lecto: *B. argenteum* Hedw.

Anomobryum Schimp., *Syn. Musc. Eur.* 382 (1860). Lecto: *A. julaceum* (Gaertn., Meyer & Scherb.) Schimp. [= *Bryum julaceum* Gaertn., Meyer & Scherb.]

Dioicous. Plants small, in dense turfs on damp soil and rock. Stems 1–4 mm long, julaceous, often branched by innovations. Leaves small, mostly less than 1 mm long, imbricate; apex obtuse to apiculate; margin usually plane, unbordered; costa weak, not reaching apex to percurrent, rarely short-excurrent, in cross-section lacking distinct guide cells; upper and mid-laminal cells rhomboidal to elongate-vermicular (3–10: 1 or more), often thick-walled; lower laminal cells abruptly quadrate to short-rectangular (1–2: 1), wider than cells above. Gemmae (leafy bulbils) often found in leaf axils of sterile shoots. Perigonial and perichaetial leaves somewhat differentiated, rather enlarged and often with acute apices. Setae long-

exserted, to 12 mm long. Capsules small, pendulous to erect, less than 1 mm long, variable in shape, ovate with a thickened neck to cylindrical with a narrow neck. Peristome double, highly variable, from well-developed with both an exostome and endostome, to the endostome segments being reduced and with low basal membrane, rarely almost lacking; cilia reduced or absent. Spores small, 8–20 µm diam. *n* = 10, 11, 12, 20 (Fritsch, 1991).

A cosmopolitan genus of c. 50–60 species, most common in montane regions of the subtropics, tropics and the Southern Hemisphere, especially well represented in the Neotropics. Only a few species occur in temperate areas of the Northern Hemisphere. Five species are known from Australia.

Spence & Ramsay (1999) observed that *Bryum*, as lectotypified by *B. argenteum*, is closely related morphologically to *Anomobryum*, and while *B. argenteum* could readily be accommodated in *Anomobryum* (Ramsay & Spence, 2002), it was not representative of most other *Bryum* species. Spence & Ramsay (1999) proposed that *B. argenteum* should be transferred to *Anomobryum*, and that *Bryum* should be conserved with a new type (*B. caespiticium*). However, the Bryophyte Committee on Nomenclature rejected the proposal as premature [(1435), *Taxon* 51: 794, 2002], especially because the choice of *B. caespiticium* as a replacement type might not prove to be appropriate. Consequently, we have redefined *Bryum* as being represented in Australia by those species listed as *Anomobryum* by Spence & Ramsay (2002), and we have placed that genus in the synonymy of *Bryum*. Other species of *Bryum s. lat.* have been reassigned to other genera with the reinstatement of *Ptychostomum* Hornsch, the acceptance of *Plagiobryum* Lindb. and the description of *Gemmabryum* and *Ochiobryum* (Spence, 2005; Spence & Ramsay, 2005).

V.F.Brotherus & W.W.Watts, The mosses of north Queensland, *Proc. Linn. Soc. New South Wales* 43: 544–567 (1918); H.Ochi, Notes on moss flora, VI, *Hikobia* 5: 153–171 (1969); J.Shaw & A.J.Fife, The evolutionary and taxonomic significance of peristome morphology in *Anomobryum* (Bryaceae, Musci), *J. Hattori Bot. Lab.* 57: 285–298 (1984); T.Koponen & D.H.Norris, Bryophyte flora of the Huon Peninsula, Papua New Guinea. IV. *Anomobryum*, *Bryum* and *Rhodobryum* (Bryaceae, Musci), *Ann. Bot. Fenn.* 21: 265–290 (1984); J.R.Spence, A proposed reclassification of *Bryum*, *Anomobryum* and *Brachymenium* (Musci, Bryaceae), *J. Bryol.* 14: 659–676 (1988); B.C.Tan & T.Koponen, Additions and corrections for the Phillipine moss flora, *Cryptog. Bryol. Lichénol.* 10: 235–245 (1989); A.Eddy, *A Handbook of Malesian Mosses* 3: 1–277 (1996); J.R.Spence & H.P.Ramsay, Proposal for the conservation of the genus *Bryum* Hedw. (Bryaceae) with a new type, *Taxon* 48: 827–828 (1999); J.-P.Frahm, The taxonomic status of *Bryum arachnoideum* C. Muell. and *B. lanatum* (P. Beauv.) Brid., *Trop. Bryol.* 21: 53–56 (2002); J.R.Spence & H.P.Ramsay, The genus *Anomobryum* Schimp. (Bryopsida, Bryaceae) in Australia, *Telopea* 9: 777–791 (2002); J.R.Spence, New genera and combinations in the Bryaceae (Bryales, Musci) for North America, *Phytologia* 87: 15–28 (2005); J.R.Spence & H.P.Ramsay, New genera and combinations in the Bryaceae (Bryales, Musci) for Australia, *Phytologia* 87: 61–71 (2005).

1 Plants silvery; upper parts of leaves hyaline; costa variable, weak to excurrent 2

1: Plants brown or green, not silvery; upper parts of leaves green; costa weak, not reaching apex (to percurrent in *B. harriottii*) 4

  2 Leaf apex obtuse or rarely slightly apiculate; apiculus < 3 µm long and acuminate; leaves often cucullate; basal laminal cells predominantly short-rectangular (2: 1); upper-middle laminal cells broad (> 14 µm) *(1)*.................................... **5. B. subrotundifolium**

  2: Leaf apex apiculate to acuminate; hairpoint or apiculus > 8 µm long; leaves not cucullate; basal laminal cells predominantly quadrate; upper and mid-laminal cells narrow (< 10 µm).................................... 3

3 Costa percurrent; leaf abruptly contracted to apiculus *(2:)* .... **1. B. argenteum**

3: Costa excurrent in a hairpoint, strong; leaf acuminate.................................... **4. B. lanatum**

  4 Upper laminal cells elongate-vermicular (> 6: 1); tropical Qld *(1:)*.................................... **2. B. auratum**

  4: Upper laminal cells short and broad (2–3: 1); Tas. .... **3. B. harriottii**

1. Bryum argenteum Hedw., *Sp. Musc. Frond.* 181 (1801)

T: Europe; holo: G? *n.v.*

Bryum argenteum Hedw. var. *niveum* Wilson, *in* J.D.Hooker, *Fl. Tasman.* 2: 191 (1859). T: Surrey Hills, Hobart, Tas., *R.C.Gunn 1615*; holo: MEL.

Bryum amblyolepis Cardot, *Rev. Bryol.* 27: 45 (1900). T: South Africa; holo: PC? *n.v.*

Bryum catenatulum Müll.Hal., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 142 (1906), *nom. nud.* (in synon.). Based on: Qld, *coll. unknown*, MEL; Mt Ararat, Vic., *coll. unknown*; *n.v.*

Bryum hampeanum Müll.Hal., *Genera Musc. Frond.* 217 (1901), *nom. nud.* (in synon.). Based on: Mt Ararat, Vic., *coll. unknown*; *n.v.*

Illustrations: A.Eddy, *Handb. Malesian Mosses* 3: 121, fig. 410 (1996); J.R.Spence & H.P.Ramsay, *Telopea* 9: 780, fig. 1 (2002), as *Anomobryum* sp.; R.D.Seppelt, *The Moss Flora of Macquarie Island* 97, fig. 36 (2004).

Plants small, in dense turfs, glossy silver-green when moist, silvery-hyaline when dry. Stems julaceous, fragile, crowded, 5–15 mm tall, branching by numerous subperichaetial innovations. Leaves ovate to ovate-lanceolate, 0.5–1.5 mm long, concave, imbricate, tapered somewhat abruptly to an obtuse apex; upper 25–50% of lamina hyaline; margin plane, usually unbordered; costa weak, percurrent or not reaching the apex, in cross-section lacking guide cells and with a reduced stereid band; upper and mid-laminal cells rhomboidal-hexagonal, 40–70 µm long, 2–4: 1, thin or firm-walled; basal laminal cells predominantly quadrate, thin-walled. Gemmae (bulbils) often present in leaf axils of sterile stems. Perichaetia on short stems; perichaetial leaves apiculate. Setae red, 12–20 mm long. Capsules short, to 2 mm long, pendulous, ovate, with a thick and often wrinkled neck, abruptly contracted to the seta, bright red at maturity; operculum convex, apiculate. Peristome double; exostome teeth 16, with a narrow border, tapering to a pale tip; outer face finely papillose; endostome segments 16, with narrow gaps; basal membrane half the height of the exostome teeth; cilia 1–3, short-appendiculate. Spores small, 8–15 µm diam. n = 10, *fide* H.P.Ramsay & J.R.Spence, *J. Hattori Bot. Lab.* 80: 258 (1996). Fig. 37A–G, Plates 37–39.

A common species throughout Australia, occurring in all States and Territories, especially in disturbed habitats, pavements, walls, soil, rock crevices, particularly in cities and towns. Prefers calcareous habitats and places with high levels of organic nitrogen. A cosmopolitan species, its distribution includes New Zealand and islands of the South Pacific. Map 155.

W.A.: Porongorups Ra., 6 Oct. 1959, *G.G.Smith* (MEL ex WAU). S.A.: Kensington Park, Adelaide, *D.G.Catcheside 79.155* (AD). N.T.: Uluru, *A.C.Beauglehole 25880* (MEL). Qld: Tinaroo Dam, *W.B.Schofield 80214* (NSW). N.S.W.: between Rous and Wardell, *H.P.Ramsay R530* (NSW). A.C.T.: Naas Ck, 35 km SE of Canberra, *H.Streimann 7937* (CANB). Vic.: Grampians, *D.Sullivan* (MEL 1000163). Tas.: Mt Wellington, 31 Mar. 1976, *D.A. & A.V.Ratkowsky* (MEL).

The abundance of *B. argenteum* in cities, in developed landscapes and other disturbed habitats, along with its general absence from native vegetation, suggest that it may have been introduced into Australia. Differences between this and the two other silvery Australian species, *B. lanatum* and ***B.** subrotundifolium*, are discussed below.

2. Bryum auratum Mitt., *J. Proc. Linn. Soc., Bot.*, Suppl. 1: 67 (1859)

Anomobryum auratum (Mitt.) A.Jaeger, *Ber. Tätigk. St. Gallischen Naturwiss. Ges.* 1873–74: 142 (1875) (Ad. 1: 804). T: Lamben R., Nepal, 7000 ft, *J.D.Hooker 513*; syn: BM?, NY.

[*Anomobryum cymbifolium auct. non* (Lindb.) Broth.: H.Streimann & N.Klazenga, *Cat. Austral. Mosses* 17 (2002)]

Illustration: H.Ochi, *Hikobia* 5: 155, fig. 36 (1969).

Plants small, in dense golden-brown turfs. Stems julaceous, branching by numerous subperichaetial innovations. Leaves imbricate, broadly ovate, concave, 0.4–0.8 mm long, with apiculate to obtuse apices; upper portion of lamina green; margin smooth; costa weak, 50–67% the length of the leaf; upper and middle laminal cells elongate-vermicular, 30–45 µm long (at least 6: 1), thick-walled; lower cells lax, quadrate to short-rectangular. Gemmae unknown. Setae short. Capsules short-ovate, horizontal to suberect, red when mature. Endostome and cilia rudimentary. Spores 11–13 µm diam. Chromosome number not known. Fig. 38A–F.

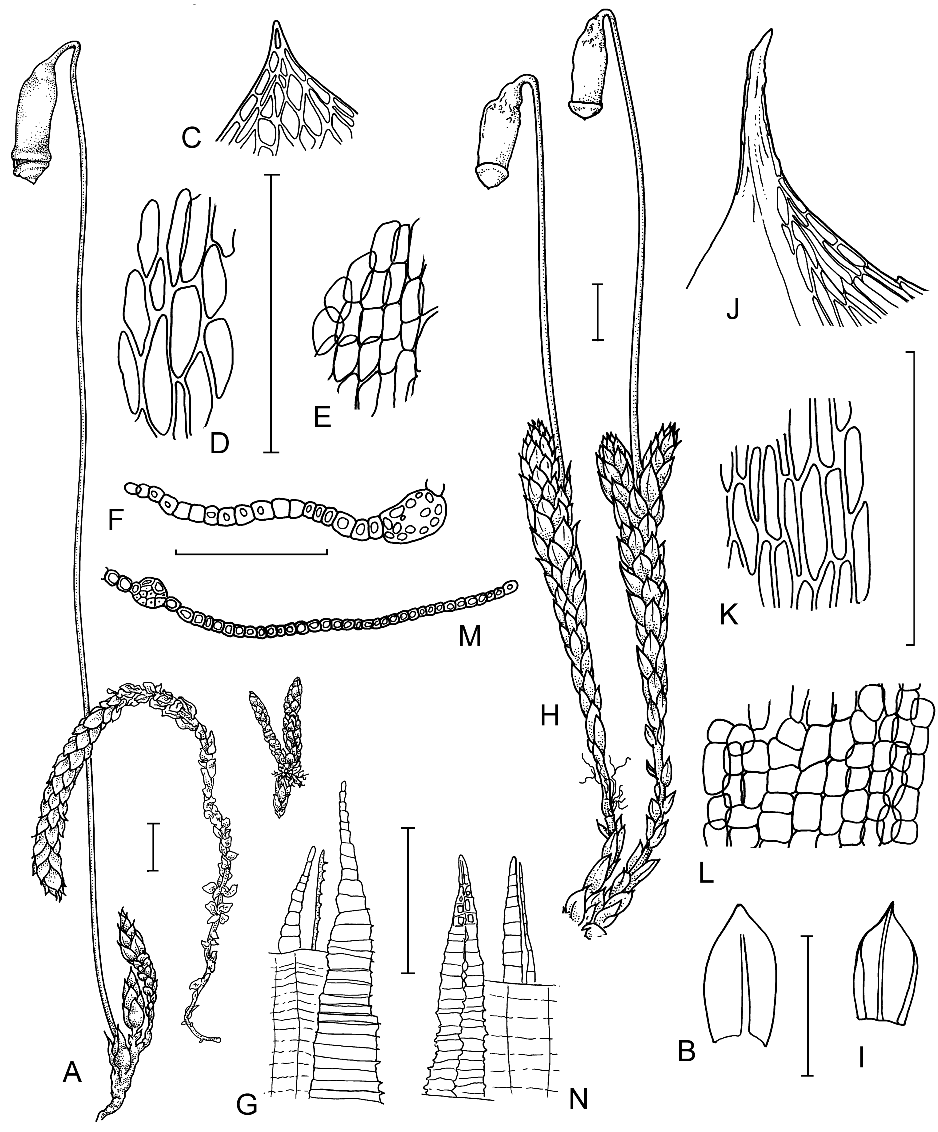


Figure 37. *Bryum*. **A–G**, *B. argenteum*. **A**, Variation in habit of dry specimens (*W.B.Schofield 80214*, NSW; *D.Sullivan s.n.*, MEL); **B**, Leaf; **C**, Apical cells of leaf; **D**, Mid-laminal cells; **E**, Basal laminal cells (B–E, *W.B.Schofield 80124*, NSW); **F**, T.S. of leaf; **G**, Peristome (F, G, *H.P.Ramsay 3/77*, NSW). **H–N**, *B. lanatum*; **H**, Habit with sporophytes (*I.G.Stone 12145*, MEL); **I**, Leaf; **J**, Apical cells of leaf; **K**, Mid-laminal cells; **L**, Basal laminal cells; **M**, T.S. of leaf (*W.B.Schofield 80214B*, NSW); **N**, Peristome (*H.P.Ramsay R173*, NSW). Scale bars: 1 mm for habits, 0.5 mm for leaves; 100 µm for cellular drawings. Drawn by L.Elkan.

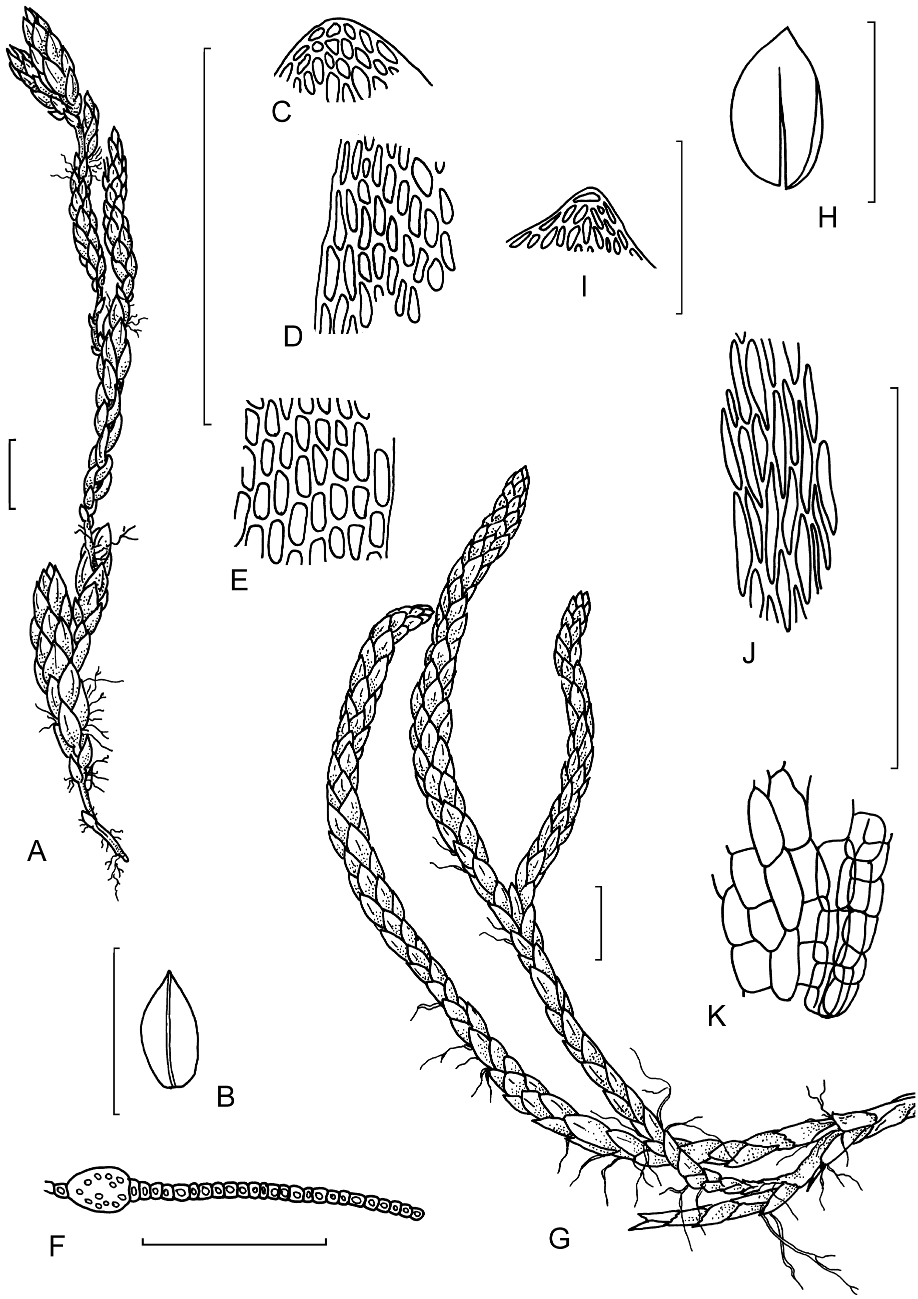


Figure 38. *Bryum*. **A–F**, *B. auratum*. **A**, Habit (dry specimen); **B**, Leaf; **C**, Apical cells of leaf; **D**, Mid-laminal cells, **E**, Basal laminal cells (A–E, *W.W.Watts Q532*, NSW); **F**, T.S. of leaf (*J.R.Spence 5124*, NSW). **G–K**, *B. harriotii*. **G**, Habit (dry specimen); **H**, Leaf; **I**, Apical cells of leaf, **J**, Mid-laminal cells; **K**, Basal laminal cells (G–K, *A.V.Ratkowsky s.n.*, HO). Scale bars: 1 mm for habits, 0.5 mm for leaves; 100 µm for cellular drawings. Drawn by L.Elkan.

Extremely rare and local in north-eastern Qld; occurs in wet soil and on splashed rocks near water at moderately high elevations (900–1000 m). Also in Africa, SE Asia and the Philippines. Map 156.

Qld: near park boundary, up-river of Little Millstream Falls, *J.R.Spence 5129* (NSW); Wallaman Falls Natl Park, *I.G.Stone 8518 p.p., 8508* (MEL); Millstream, Ravenshoe, *W.W.Watts Q532* (NSW).

Australian collections are sterile, and the foregoing description of the sporophyte is based on that of Ochi (*op cit.* 154, 1969). Consequently, the identification of Australian plants remains tentative until sporophytes are found. Although the plants are similar to named specimens from elsewhere, they are somewhat smaller.

3. **Bryum harriottii** R.Br.bis, *Trans. & Proc. New Zealand Inst.* 31: 453 (1899)

Anomobryum harriottii (R.Br.bis) Dixon, *Bull. New Zealand Inst.* 3: 202 (1926). T: wet banks near Weka Pass, New Zealand, Apr. 1882, *R.Brown s.n.*; holo: WELT?

Illustrations: J.R.Spence & H.P.Ramsay, *Telopea* 9: 784, fig. 3 (2002), as *Anomobryum harriottii*; R.D.Seppelt, *The Moss Flora of Macquarie Island* 103, fig. 39 (2004).

Small plants in dense bright green turfs. Stems julaceous, to 20 mm tall, with numerous subperichaetial innovations. Leaves imbricate, ovate to orbicular, to 1 mm long, concave; upper portion of leaf green; apex obtuse; margin smooth; costa strong, almost reaching apex to percurrent; upper and middle laminal cells short and broad, 10–25 × 5–6 µm (2–4: 1), incrassate; basal cells short-rectangular. Gemmae unknown. Setae 10–20 mm long. Capsules horizontal to pendulous, ovate to pyriform, with a narrow neck. Peristome double; exostome teeth 16; endostome segments reduced, with a short basal membrane; cilia absent or rudimentary. Spores 20–25 µm diam. Chromosome number not known. Fig. 38G–K.

Very rare in Tas., but possibly overlooked; grows on damp rocks or soil-filled crevices on outcrops. Also in Macquarie Is. and widespread in the mountains of New Zealand as well as similar habitats in the New Zealand Subantarctic islands. Map 157.

Tas.: Mt Franklin, 7 Jan. 1978, *A.V.Ratkowsky s.n.* (HO).

Australian collections are sterile, and the foregoing description of the sporophyte is taken from G.O.K.Sainsbury (*Bull. Roy. Soc. New Zealand* 5: 269, 1955). This species can be distinguished from *B. auratum* by the bright green colour and broad upper laminal cells.

4. **Bryum lanatum** (P.Beauv.) Brid., *Muscol. Recent.*, Suppl. 3: 20 (1817)

Mnium lanatum P.Beauv., *Prodr. Aethéogam.* 75 (1805); *Bryum argenteum* Hedw. var. *lanatum* (P.Beauv.) Hampe, *Linnaea* 13: 44 (1839); *Bryol. Eur.* 4: 148 (1839) (Fasc. 6–9, Mon. 78); *Anomobryum lanatum* (P.Beauv.) J.R.Spence & H.P.Ramsay, *Telopea* 9: 785 (2002). T: locality not known.

Bryum bateae Müll.Hal., *Hedwigia* 37: 93 (1898). T: Mt Dromedary, N.S.W., 1883, *Miss Bate*; holo: MEL; iso: NSW.

Bryum austroargenteum Broth. ex Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 127 (1906), *nom. nud.* (in synon.). Based on: [Milton], Brisbane, Qld, *H.Tryon s.n.* (BRI, MEL).

Bryum rotundum Hampe ex Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 143 (1906), *nom. nud.* Based on: Ararat, Vic., *F.M.Campbell s.n.* (BRI, MEL).

Illustrations: H.Crum & L.E.Anderson, *Mosses of Eastern North America* 2: 671, fig. 265H–I (1981), as *Bryum argenteum* var. *lanatum*; J.R.Spence & H.P.Ramsay, *Telopea* 9: 786, fig. 4 (2002), as *Anomobryum lanatum*.

Plants small, in dense hoary silver-white tufts. Stems julaceous, crowded, 5–15 mm tall, branching by numerous perichaetial innovations. Leaves imbricate, ovate-lanceolate, acuminate with a hyaline apex, 0.5–1.5 mm long; upper 25–50% of lamina hyaline; margin plane, mostly unbordered; costa strong, excurrent into a slender silver hairpoint, often weakly recurved when dry, in cross-section lacking guide cells and with a reduced stereid band; upper and mid-laminal cells rhomboidal-hexagonal, 25–30 × 6–8 µm (3–4: 1), firm-walled to incrassate; basal laminal cells predominantly quadrate, thin-walled. Gemmae as axillary leafy bulbils on sterile stems. Perichaetial leaves lanceolate, acuminate, with a long hairpoint. Setae 15–20 mm long. Capsules rare, short, pendulous, to 2 mm long, ovate with a

wide mouth and a thick and often wrinkled neck. Peristome double; exostome teeth 16, tapering; endostome segments 16; basal membrane at least half the height of the exostome; cilia 1–3, appendiculate. Spores small, 8–15 µm diam. Chromosome number not known. Fig. 37H–N.

Widespread on dry soil or rock, especially in more arid parts of Australia (W.A., S.A., N.T., Qld, N.S.W., A.C.T. and Vic.) More common in the subtropical and tropical areas of Indo-Malesia. Map 158.

W.A.: near Qualip HS, Fitzgerald R., *J.R.Spence 4165* (NSW). S.A.: Wilpena Pound, *D.G.Catcheside 53.238* (AD). N.T.: Mt Olga Gorge, *I.G.Stone 5140* (MEL). Qld: Mt Bellenden Ker, *I.G.Stone 12145* (MEL). N.S.W.: Mt Tinderry, Michelago, *H.Streimann 5215* (AD).

Although commonly considered to be a variety of *B. argenteum*, this is morphologically quite distinct among the silver species of *Bryum*, i.e. unlike most others, *B. lanatum* has a strong costa that is excurrent into a long, hyaline hairpoint. The presence of the hairpoint gives the species a hoary, whitish look. A few specimens are intermediate between *B. lanatum* and *B. argenteum*, or occasionally display leaves of both types. However, where both species occur together they are distinct. Until more detailed studies of all silvery species are completed, we prefer to recognise *B. lanatum* as a discrete taxon.

5. Bryum subrotundifolium A.Jaeger, *Ber. Tätigk. St. Gallischen Naturwiss. Ges*. 1877–78: 43 (1879)

Argyrobryum subrotundum Hampe, *Linnaea* 40: 312 (1876), *nom. inval.*; *Anomobryum subrotundifolium* (A.Jaeger) J.R.Spence & H.P.Ramsay, *Telopea* 9: 787 (2002). T: Mt Ararat, Vic., 1875, *D.Sullivan s.n.*; iso: MEL, NSW.

Illustrations: R.D.Seppelt & T.G.A.Greene, *New Zealand J. Bot*. 36: 628, fig. 8; 629, fig. 9 (1998); J.R.Spence & H.P.Ramsay, *Telopea* 9: 788, fig. 5 (2002), as *Anomobryum subrotundifolium*.

Plants small, in dense silver-green turfs. Stems julaceous, fragile, 5–20 mm tall, sparsely branched by subperichaetial innovations. Leaves imbricate, broadly ovate to broadly ovate-lanceolate, 0.5–1.5 mm long, obtuse or occasionally tapered somewhat abruptly to a short apiculus (less than 3 µm), concave, often cucullate; upper 25–50% of lamina hyaline; margin plane, mostly unbordered; costa weak, percurrent or not reaching apex, in cross-section lacking guide cells and with a reduced stereid band; upper and mid-laminal cells rhomboidal-hexagonal, mostly more than 16 µm wide (2–3: 1), thin- or often firm-walled; basal laminal cells predominantly short-rectangular (2: 1), thin-walled. Gemmae not known; Australian plants sterile. Chromosome number not known.

Occurs in W.A., N.T., A.C.T., Vic. and Tas.; grows on dry rock or on soil over rock in exposed sites, often at moderately high elevations. Also in Macquarie Is. and Antarctica. Map 159.

W.A.: Boorara, 10 km ESE of Kalgoorlie, *D.Kemsley* (MEL). N.T.: Kings Canyon, George Gill Ra., 2 July 1965, *A.C.Beauglehole* (MEL). A.C.T.: Cave Ck, Blue Waterholes, *J.R.Spence 4470 & H.Streimann* (NSW). Vic.: Parkville, Melbourne, *I.G.Stone 11893* (MEL). Tas.: Mt Wellington, *D.A. & A.V.Ratkowsky B368* (MEL).

A poorly known and undercollected species, *B. subrotundifolium* is related to the silvery taxa *B. argenteum* and *B. lanatum*, but differs in the obtuse leaf apices, often cucullate leaves, broad laminal cells, the absence of a hairpoint or apiculus, and basal laminal cells that are rectangular rather than quadrate. Recent molecular and morphological studies also confirm its separation from *B. argenteum* (P.Selkirk, pers. comm.).

Excluded Species

Anomobryum filescens E.B.Bartram, *Trans. Brit. Bryol. Soc.* 1: 468 (1951)

This species was reported from W.A. by Bartram (1951). According to Scott & Stone (1976, p. 124), the specimen is *Eccremidium pulchellum* (Hook.f. & Wilson) Müll.Hal. (Ditrichaceae).

3. GEMMABRYUM

Gemmabryum J.R.Spence & H.P.Ramsay, *Phytologia* 87: 63 (2005); the name refers to the importance of the three different types of asexual gemmae in the genus.

Type: *G. pachythecum* (Müll.Hal.) J.R.Spence & H.P.Ramsay

Dioicous or, rarely, synoicous. Plants perennial, small to robust, in ±dense tufts or turfs, or sometimes scattered among other mosses. Stems erect, mostly branched by perichaetial innovation, usually not markedly radiculose. Rhizoids usually pale or red to red-brown, rarely purple, papillose. Leaves usually crowded and imbricate on elongate stems, sometimes reddish, not especially enlarged above, usually not much altered when moist or dry, plane to weakly concave, mostly ovate, ovate-lanceolate or lanceolate, sometimes obtuse or rounded; margin smooth to serrulate, usually without a border; costa single, well developed, percurrent to long-excurrent as a stout point, prominent at back, with 1 layer of guide cells present above a single dorsal stereid band; upper laminal cells linear-vermicular to hexagonal, usually rather narrow and often thick-walled; lower cells quadrate to short-rectangular (1–2: 1), often broader than upper cells and usually with an abrupt transition; occasionally lower cells similar to upper cells, then all cells very thick-walled and often at an oblique angle to the costa. Gemmae commonly produced as rhizoidal tubers, stem tubers or axillary leaf bulbils. Perigonial and perichaetial leaves not strongly differentiated from vegetative leaves. Setae flexuose, curved or hooked at tip, reddish. Capsules nodding, pendent or erect, smooth, clavate, pyriform or ovoid to subglobose, often with a thick corrugated neck; stomata superficial, numerous in neck; annulus large and revoluble; operculum hemispherical or convex, conical, umbonate or minutely apiculate. Peristome double; exostome teeth acuminate, fused at the extreme base, yellow to brown, hyaline at tip, generally densely papillose on outer surface, usually bordered; endostome extremely variable, pale, finely papillose; basal membrane well developed; segments keeled and perforate to poorly developed; cilia 0–4, nodulose or appendiculate, rudimentary or lacking in species with erect capsules. Spores small to medium, 8–20 (–25) µm diam. *n* = 10, 11, 20, 21, 30 in Australian species (see below).

A genus of c. 150 species; 25 species in Australia. Occurs in alpine, temperate to tropical regions, most common on soil (sometimes over rock), often in disturbed areas or on wet rocks near cliffs; rare in the polar regions.

Species of *Gemmabryum* have *Bryum*-like laminal areolation, but the genus is distinguished from the closely allied *Bryum* by a number of morphological features. Stems tend to be bud-like or, if elongate, they are not julaceous, and the costa is typically excurrent. Most species of *Bryum* are julaceous and the leaves have a weak costa not reaching the apex, except for the atypical *B. lanatum*. Three distinct types of gemmae are commonly produced in *Gemmabryum*: rhizoidal tubers, stem tubers and axillary bulbils; a few species have been reported with uniseriate, filiform rhizoidal gemmae. Some species do not produce gemmae but, based on other attributes, they are clearly referable to *Gemmabryum*; moreover, a few of these species are known to produce gemmae in culture. In cross-section the costa has a well-developed layer of guide cells, unlike *Bryum*. Four traditional sections of *Bryum* and *Brachymenium* belong to *Gemmabryum*: *Bryum* sections *Alpiniformia*, *Apalodictyon* and *Doliolidium* and *Brachymenium* sect. *Dicranobryum*. The sectional names above are not used in the current treatment because numerous nomenclatural problems exist (see Isoviita, *in* Ochi, 1992). Chromosome numbers are based on x =10 with many polyploids and aneuploids (see R.Fritsch, *Bryophyt. Biblioth.* 40: 1–326, 1991).

J.R.Spence & H.P.Ramsay, New genera and combinations in the Bryaceae (Bryales, Musci) for Australia, *Phytologia* 87: 61–71 (2005).

1 Leaves rather thick, somewhat fleshy; laminal areolation dense; cells thick-walled; upper laminal cells hexagonal, 2–4: 1, those in upper third of the leaf angled away from costa at 20–45°; lower cells similar in size, not oblique, rectangular, transition from upper to lower cells rather gradual; asexual gemmae usually lacking (rhizoidal tubers rarely present) 2

1: Leaves thin, not fleshy; laminal areolation not noticeably dense; laminal cells thin- to somewhat thick-walled; upper cells linear-vermicular to hexagonal, 3–8: 1, not angled away from costa; lower cells typically abruptly shorter and broader than cells above, quadrate to short-rectangular, 1–2: 1 (at least in the alar region); asexual gemmae commonly present, of various kinds 4

2 Plants large; stems usually more than 20 mm long; costa percurrent; leaf apex obtuse to broadly acute *(1)* .... **17. G. laevigatum**

2: Plants smaller; stems usually less than 20 mm long; costa excurrent as a short stout point; leaf apex acute 3

3 Leaves unbordered, strongly concave; lower laminal cells quadrate; stems often consisting of one or more imbricate comal tufts of leaves; on damp to dry soil, sand and rock; not encrusted with carbonates *(2:)* .... **10. G. crassum**

3: Leaves bordered at least in lower half, only weakly concave; lower laminal cells mixed quadrate and short-rectangular; stems with equidistant leaves, not in comal tufts; on wet rock or soil over rock; often encrusted with carbonates .... **7. G. clavatum**

4 Gemmae present as rhizoidal tubers; leaf axil bulbils rare *(1:)* 5

4: Gemmae present as leaf axil bulbils or stem tubers, sometimes lacking; rhizoidal tubers lacking 16

5 Tubers sparse, in tomentum on stem or clustered at stem base; leaves strongly imbricate when moist and dry, triangular to ovate, often reddish and glossy; upper and middle laminal cells somewhat incrassate; on damp or wet rock or on soil over rock near water *(4)* 6

5: Tubers common to abundant, typically at stem base or on rhizoids in the substratum; leaves slightly twisted or contorted at tips when dry, erect-spreading when moist, ovate to ovate-lanceolate, rarely red near leaf base, glossy or not; upper and middle laminal cells mostly thin-walled; on damp or dry soil or around temporary pools, often in disturbed sites 7

6 Plants golden-brown, glossy, usually lacking red tints; costa long-excurrent in a stiff hairpoint; leaves mostly triangular *(5)* .... **3. G. australe**

6: Plants red or red-green, dull or glossy; costa short-excurrent as a stout point; leaves ovate .... **5. G. cheelii**

7 Tubers small, mostly < 100 µm long, although a few larger tubers sometimes present *(5:)* 8

7: Tubers larger, mostly > 120 µm long; smaller tubers sometimes present 10

8 Median laminal cells elongate, 6: 1 or more; some cells > 100 µm long; alar cells differentiated, quadrate; justacostal cells elongate; bulbils sometimes present in leaf axils *(7)* .... **2. G. apiculatum**

8: Median laminal cells shorter, mostly 3–6: 1 and < 80 µm long; cells across leaf base differentiated, quadrate to short-rectangular, 1–2: 1; bulbils lacking in leaf axils 9

9 Synoicous or dioicous; tubers brown, red-brown or golden-brown, pyriform, mostly 2 or 3 cells across; cells not protuberant *(8:)* .... **22. G. sauteri**

9: Dioicous; tubers red, globose, mostly > 3 cells across; cells protuberant .... **16. G. klinggraeffii**

10 Capsules erect; peristome reduced; cilia lacking; bulbils sometimes present in leaf axils *(7:)* 11

10: Capsules inclined to nodding; peristome well developed; bulbils lacking in leaf axils 12

11 Synoicous; leaves ovate-lanceolate, slightly twisted when dry, green; costa excurrent into a long hairpoint *(10)* .... **15. G. indicum**

11: Dioicous; leaves ovate, imbricate or folded along costa but not twisted when dry, golden-green; costa percurrent to excurrent in a short stout point .... **13. G. exile**

12 Leaves bordered; median laminal cells 10–16 µm wide; plants often with red tints; tubers red, mostly clustered at leaf bases *(11:)* .... **21. G. rubens**

12: Leaves not bordered; median laminal cells 10–14 (–16) µm; plants mostly green or brown-green or golden; tubers on rhizoids in substratum or rarely in tomentum on stem 13

13 Costa strong, long-excurrent in a golden hairpoint; basal laminal cells mostly quadrate, at least in alar region, mixed with a few short-rectangular cells; tubers red, often on stem, some > 500 µm long, with cells distinctly protuberant at ×30–40 magnification *(12:)* .... **6. G. chrysoneuron**

13: Costa short- or long-excurrent; basal laminal cells mostly either quadrate or short-rectangular; tubers < 300 µm long, yellow, brown or red; cells not protuberant 14

14 Tubers golden-yellow throughout, mostly < 200 µm long; internal cell walls red *(13:)* ....

.... **25. G. tenuisetum**

14: Tubers red to red-brown, of various sizes; cell walls concolorous 15

15 Costa long-excurrent in a long hairpoint; tubers brown to red, mostly < 200 µm long; basal laminal cells mostly quadrate; calcicolous *(14:)* .... **20. G. radiculosum**

15: Costa weaker, short-excurrent in a short hairpoint; tubers red, many > 200 µm long; basal laminal cells mostly short-rectangular; calcifugous .... **23. G. subapiculatum**

16 Bulbils present in axils of upper leaves, mostly on sterile shoots *(4:)* 17

16: Bulbils lacking 25

17 Median laminal cells elongate, 6: 1 or more, some cells > 100 µm long; alar cells differentiated, quadrate; justacostal cells elongate *(16)* .... **2. G. apiculatum**

17: Median laminal cells shorter, mostly 3–6: 1, mostly < 80 µm long; cells across leaf base differentiated, quadrate to short-rectangular, 1–2: 1 18

18 Synoicous; capsules erect, with a reduced peristome; neck not inflated; leaves somewhat twisted when dry *(17:)* .... **15. G. indicum**

18: Dioicous; capsules inclined to nodding, rarely erect; neck often distinctly inflated; leaves mostly imbricate when dry 19

19 Stems elongate (> 10 mm); leaves ovate, cucullate near tip of stem, strongly concave; costa percurrent or not reaching apex; bulbils present, with distinct leafy tips *(18:)* .... **24. G. sullivanii**

19: Stems mostly short (< 10 mm); leaf shapes various, not cucullate, plane or weakly concave; costa generally short- to long-excurrent into a distinct hairpoint; bulbils various 20

20 Leaves ovate, widest in the middle *(19:)* 21

20: Leaves ovate-lanceolate, lanceolate or triangular, widest below the middle 22

21 Costa long-excurrent into an often hyaline spinulose hairpoint; plants generally with a reddish tint; capsule neck corrugate, abruptly contracted to seta; stem tubers sometimes present *(20)* .... **12. G. eremaeum**

21: Costa percurrent to short-excurrent, golden-brown; hairpoint smooth; plants lacking red tints; capsule neck smooth to somewhat corrugate, tapered to seta; stem tubers lacking .... **13. G. exile**

22 Bulbils with distinct leafy primordia, generally 1 per axil; capsule neck thick and corrugate, or smooth to wrinkled and tapered to the seta *(20:)* 23

22: Bulbils lacking leafy primordia, often many per axil; capsule neck thick, corrugate, abruptly contracted to seta 24

23 Capsule neck smooth or wrinkled, tapered; leaves ovate-lanceolate; leaf margin plane or recurved to midleaf *(22)* .... **11. G. dichotomum**

23: Capsule neck thick and corrugate and abruptly contracted to seta; leaves lanceolate or triangular; leaf margin strongly recurved to near apex .... **9. G. coronatum**

24 Hairpoint hyaline; bulbils with small peg-like primordia at tip; apex often irregularly grooved between tips; stem tubers often present *(22:)* .... **12. G. eremaeum**

24: Hairpoint usually golden-brown or red; bulbils lacking primordia; apex smooth; stem tubers absent .... **18. G. pachythecum**

25 Median laminal cells elongate, 6: 1 or more, some > 100 µm; alar cells differentiated, quadrate; justacostal cells elongate; plants glossy yellow or silver-green, in thin mats; stems evenly foliate *(16:)* 26

25: Median laminal cells shorter, mostly 3–6: 1, mostly < 80 µm; cells across leaf base differentiated, quadrate to short-rectangular, 1–2: 1; plants dull or glossy green or red-green; stems mostly gemmiform to evenly foliate 27

26 Plants yellow-green; capsules inclined to nodding, tapering to a somewhat narrowed mouth; peristome well developed; cilia present; basal membrane high *(25)* .... **14. G. inaequale**

26: Plants green to silver-green; older leaves losing chlorophyll; capsules erect or suberect, widest at mouth; peristome reduced; cilia short or absent; basal membrane low .... **1. G. acuminatum**

27 Leaves strongly imbricate, not twisted or contorted when dry (although sometimes folded); margin plane or recurved near base; costa percurrent to excurrent as a short stout point *(25:)* 28

27: Leaves loosely imbricate, somewhat contorted or twisted when dry; margin recurved to mid-leaf or beyond; costa strong, long-excurrent as a long smooth to spinulose hairpoint 30

28 Leaves ovate-lanceolate to triangular; capsules common, tapered to a narrow mouth; operculum distinctly rostrate *(27)* .... **19. G. preissianum**

28: Leaves ovate; capsules rare, with a wide mouth; operculum short-conical 29

29 Leaves often smoothly folded along costa; capsules erect; peristome reduced; cilia short or absent; basal membrane low; bulbils sometimes present in leaf axils *(28:)*......................................**13. G. exile**

29: Leaves imbricate, not folded; capsules nodding; peristome well developed; cilia present; basal membrane high; bulbils lacking in leaf axils...**4. G. austrosabulosum**

30 Leaf tips hyaline; leaves bordered at least above; hairpoint hyaline at least at tip, spinulose; stem tubers often present; other gemmae lacking *(27:)*...**8. G. coarctatum**

30: Leaf tips coloured; leaves unbordered; hairpoint coloured, mostly smooth; stem tubers absent; rhizoidal tubers and leaf axil bulbils sometimes present...**15. G. indicum**

1. Gemmabryum acuminatum (Harv. ex Hook.) J.R.Spence & H.P.Ramsay, *Phytologia* 87: 65 (2005)

Brachymenium acuminatum Harv. ex Hook., *Icon. Pl.* 1: 19 (1836). T: Nepal, *Wallich s.n.*; holo: BM.

Bryum multicaule Taylor, *London J. Bot.* 5: 53 (1846). T: Swan R., W.A., *J.Drummond 27*; holo: BM.

Brachymenium mielichhoferioides Müll.Hal., *Nuovo Giorn. Bot. Ital.* 4: 216 (1872). T: Africa; iso: H.

Illustrations: H.C.Gangulee, *Mosses of Eastern India and Adjacent Regions* 4: 951, fig. 457 (1974), as *Brachymenium acuminatum*; H.Ochi, *J. Fac. Educ. Tottori Univ. Nat. Sci.* 21: 11, fig. 2A–G (type of *Bryum multicaule*); 12, fig. 3 (isotype of *Brachymenium mielochhoferioides*) (1970); A.Eddy, *Handb. Malesian Mosses* 3: 170, fig. 446E–J (1996), as *Brachymenium acuminatum.*

Dioicous. Plants in dense mats, less than 5 mm tall, green, yellowish green or silvery, distinctly glossy, with tightly appressed leaves, matted with red tomentum below. Rhizoids red, papillose. Leaves lanceolate to ovate, acute to acuminate, concave, crowded, imbricate, to 2 mm long, erect with spreading apices; margin ±entire, plane, slightly revolute near base; costa excurrent but not forming a long hairpoint or arista, yellowish; upper laminal cells long and narrow, to 140 × 8–11 µm (6–8: 1), thick-walled, extending to leaf base along costa; cells in alar region quadrate, thin-walled, distinctly different to justacostal cells. Gemmae lacking. Fertile stems short. Setae c. 40 mm long, pale brown to red-brown. Capsules erect to inclined, large in comparison to gametophyte, 2–3 mm long, broadly fusiform, widest at the mouth; operculum conical, sometimes umbonate. Peristome reduced; exostome teeth 16, orange, faintly papillose, externally trabeculate; endostome reduced, essentially a high basal membrane and short blunt or rudimentary segments; cilia absent or as blunt traces only. Spores 10–16 µm diam. Chromosome number not known.

Occurs in north-eastern Qld and south-western W.A.; occurs on soil in open *Eucalyptus* woodland. A pantropical and highly variable species. Map 160.

Qld: Herberton–Petford road, *H.Streimann 29935* (CANB); near Blencoe Falls, Kirrama area, *J.R.Spence 5136* (NSW).

Gemmabryum acuminatum is very similar to *G. inaequale*, but it can be distinguished by the reduced peristome, capsules that are broadest at the mouth and shoots that often become silvery with age due to loss of chlorophyll in their upper parts. In *G. inaequale* the peristome is not reduced, the capsule tapers towards the mouth, and the shoots tend to be yellow-green.

A report of *G. acuminatum* from Perth, W.A. by Ochi (1970) was based on a specimen of *G. inaequale.*

2. Gemmabryum apiculatum (Schwägr.) J.R.Spence & H.P.Ramsay, *Phytologia* 87: 65 (2005)

Bryum apiculatum Schwägr., *Sp. Musc. Frond.*, Suppl. 1, 2: 102, t. 72 (1816). T: “In America meridionalis lectum, ni fallor, Richardus dedit”; holo: G.

Bryum nitens Hook., *Icon. Pl.* 1: 19 (1836). T: locality not known; BM?, *fide* H.Ochi, *J. Fac. Educ. Tottori Univ. Nat. Sci.* 21: 34–35 (1970).

Bryum plumosum Dozy & Molk., *Ann. Sci. Nat. Bot.*, sér. 3, 2: 301 (1844). T: locality not known; L, *fide* H.Ochi, *op. cit.* 36.

Bryum subpachypoma Hampe, *Linnaea* 36: 518 (1870). T: Rockingham’s Bay, Qld, *F.Mueller*; holo: BM; iso: BRI, H-BR, MEL, NSW.

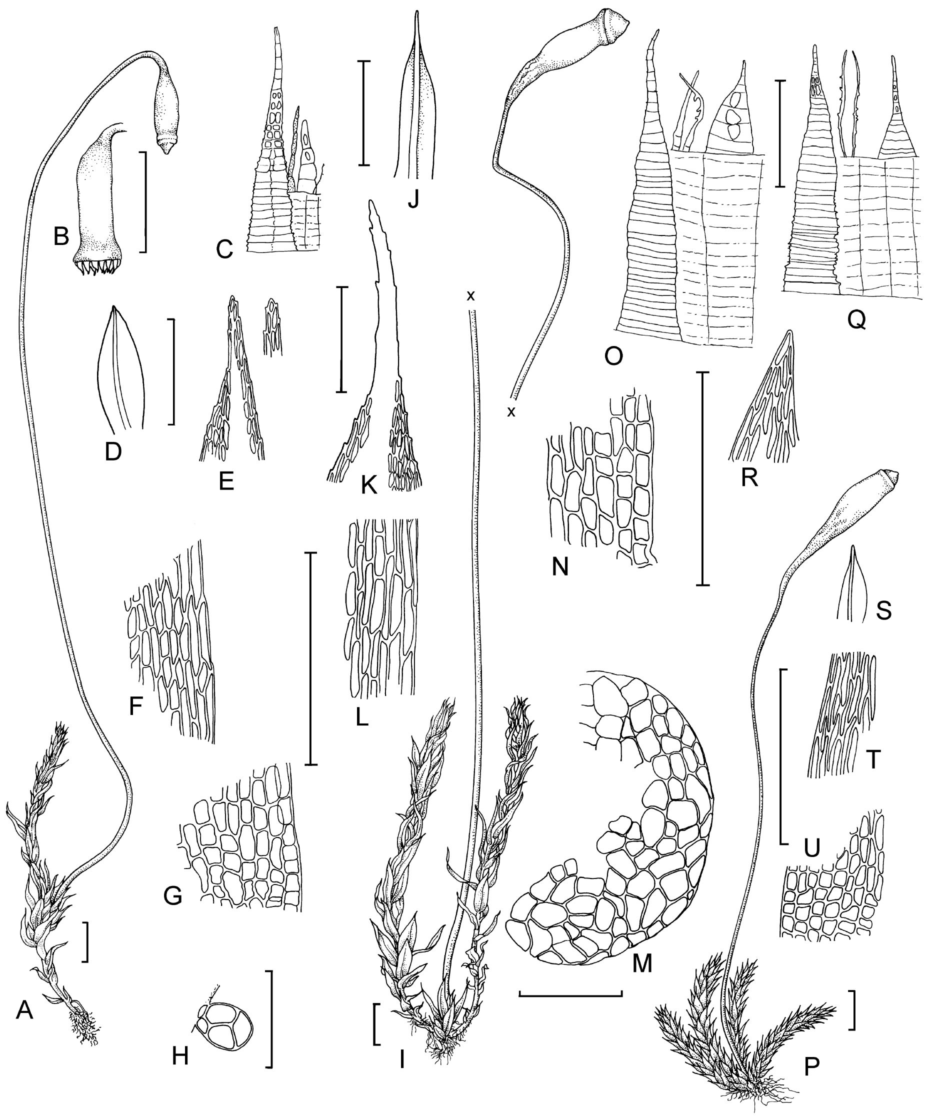


Figure 39. *Gemmabryum*. **A–H**, *G. apiculatum*. **A**, Habit with sporophyte (dry specimen); **B**, Capsule with peristome; **C**, Peristome: exostome tooth (left); endostome basal membrane with cilium (centre); and segment with cilium (right); **D**, Leaf; **E**, Cells at leaf apex; **F**, Mid-laminal cells; **G**, Basal laminal cells; **H**, Gemma (rhizoidal tuber) (A–H, *C.B.Kaye s.n.*, MEL). **I–O**, *G. chrysoneuron*. **I**, Habit with sporophyte (dry specimen); **J**, Leaf; **K**, Cells at leaf apex; **L**, Mid-laminal cells; **M**, Rhizoidal gemma (ruptured); **N**, Basal laminal cells (I–N, *E.Cheel s.n.*, NSW); **O**, Peristome: exostome tooth (left); endostome with basal membrane and 2 cilia (centre); and broad endostome segment (right) (*G.K.Thomson s.n.*, MEL 29852). **P–U**, *G. inaequale*. **P**, Habit with sporophyte (dry specimen); **Q**, Peristome: exostome tooth (left); endostome with high basal membrane and 2 cilia (centre); and endostome segment (right); **R**, Cells at leaf apex; **S**, Leaf; **T**, Mid-laminal cells; **U**, Basal laminal cells (P–U, *L.D.Williams 3537*, AD). Scale bars: 1 mm for habit; 0.5 mm for leaves, 100 µm for cellular drawings. Drawn by N.Oram.

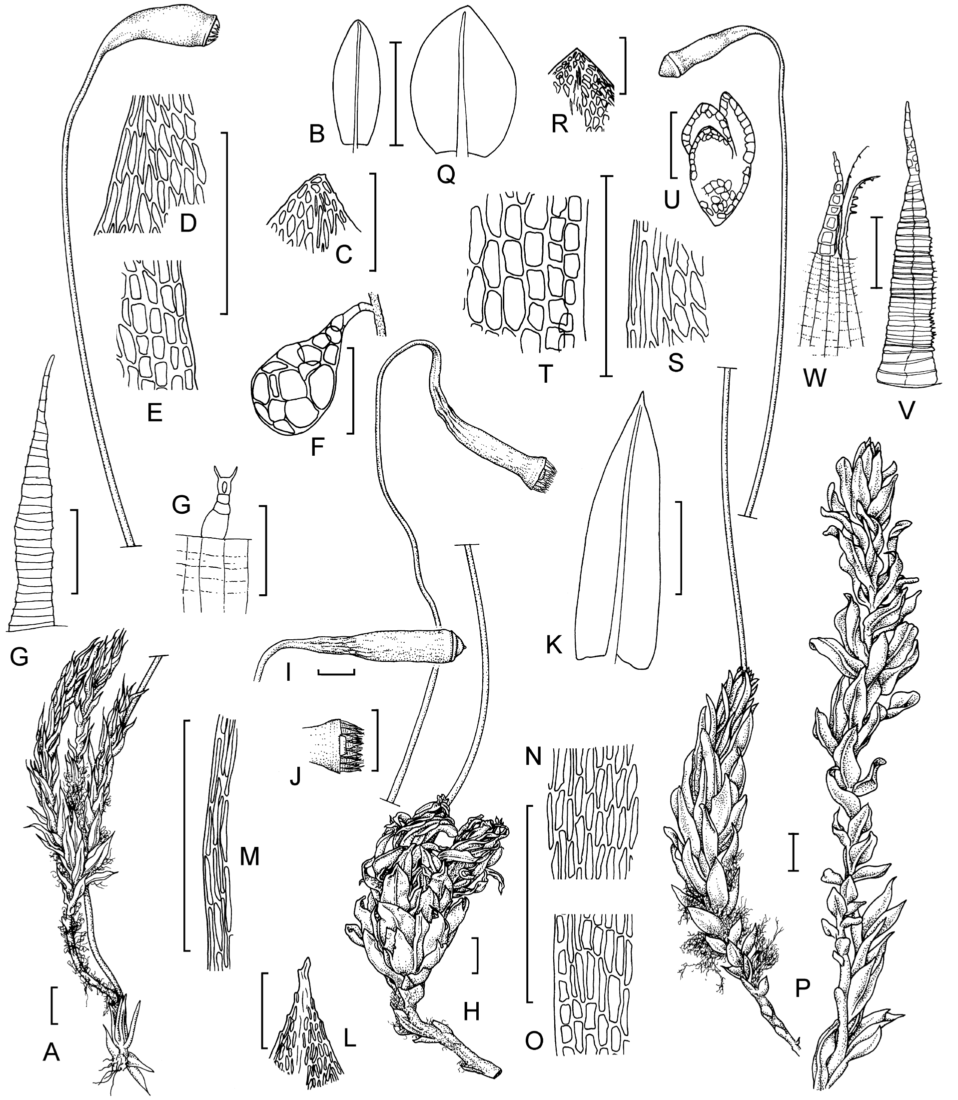


Figure 40. *Gemmabryum*. **A–G**, *G. clavatum*. **A**, Habit with sporophyte; **B**, Leaf; **C**, Cells at leaf apex; **D**, Mid-laminal cells; **E**, Basal laminal cells; **F**, Gemma (rhizoidal tuber) (A–F, *J.R.Spence 4518*, NSW); **G**, Peristome: exostome (left) and endostome (right) (*H.P.Ramsay 32/77*, NSW). **H–O**, *G. crassum*. **H**, Habit with sporophyte; **I**, Capsule with operculum; **J**, Mouth of capsule with peristome teeth (H–J, W.W.Watts, NSW); **K**, Leaf; **L**, Cells at leaf apex; **M**, Marginal cells; **N**, Mid-laminal cells; **O**, Basal laminal cells (K–O, *I.G.Stone 3441*, MEL). **P–W**, *G. laevigatum*. **P**, Habit: sterile (right) and with sporophyte (left); **Q**, Leaf; **R**, Cells at leaf apex; **S**, Mid-laminal cells; **T**, Basal laminal cells; **U**, Gemma (axillary bulbil) (O–U, *I.G.Stone 3177*, MEL); **V**, exostome; **W**, endostome (V, W, *H.P.Ramsay R1637*, NSW). Scale bars: 1 mm for habit; 0.5 mm for leaves, 100 µm for cellular drawings. Drawn by L.Elkan.

Bryum baileyi Broth., *Oefvers. Förh. Finska Vetensk.-Soc.* 33: 100 (1891). T: Freshwater Creek, Trinity Bay, Qld, 1889, *F.M.Bailey 646*; holo: H-BR; iso: BRI, NSW.

Bryum pachypomatulum Broth., *Oefvers. Förh. Finska Vetensk.-Soc.* 42: 103 (1900). T: Richmond R., Ballina, N.S.W., *W.W.Watts 1962*; holo: H-BR; iso: BM, NSW.

Bryum micropachypomum Broth. ex Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 136 (1906), *nom. nud.* (in synon.). T: see *Bryum pachypomatulum*; based on the same specimen.

Bryum tenuicostatum Broth., *in* W.W.Watts & T.Whitelegge, *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 143 (1906), *nom. nud.* (in synon.). Based on: German Ck, N.S.W., July 1900, *W.W.Watts 4410* (NSW).

Bryum kurandae Broth. & Watts, *Proc. Linn. Soc. New South Wales* 43: 554 (1918). T: Kuranda, Qld, 1913, *W.W.Watts Q498*; holo: H-BR; iso: NSW.

Brachymenium wattsii Broth., *in* V.F.Brotherus & W.W.Watts, *Proc. Linn. Soc. New South Wales* 43: 554 (1918). T: Millstream, Ravenshoe, Qld, 1913, *W.W.Watts 489*, *527*; syn: H-BR; isosyn: NSW.

Illustrations: A.Eddy, *Handb. Malesian Mosses* 3: 125, fig. 413 (1996), as *Bryum apiculatum*; H.Streimann, *The Mosses of Norfolk Island* 20, fig. 6 (2002), as *Bryum apiculatum.*

Dioicous. Plants variable, mostly small. Stems to 20 mm long, glossy green or yellow-green, often red-tinged. Rhizoids red-brown. Leaves small, lanceolate to ovate, shallowly concave, to 1.5 mm long, widest at mid-leaf, slightly contorted when dry, somewhat imbricate; margin plane or slightly revolute near insertion, with a poorly defined border of 1 or 2 rows of elongate cells; costa strong, percurrent or occasionally very short-excurrent; upper laminal cells rhomboidal-rectangular, elongate, narrow and somewhat thin-walled, 80–100 µm long, 8–15 µm wide (6–8: 1); alar region differentiated, of fewer than 10 quadrate thin-walled often red-tinted cells; justacostal cells elongate. Gemmae usually present as red or brown pyriform to irregularly globose rhizoidal tubers, 40–100 µm; leaf axil bulbils sometimes present, with leafy primordia. Perichaetia on short stems; leaves differentiated. Setae 25–30 mm long, reddish. Capsules cylindrical, 2–3 mm long, short-necked, widest at mouth; operculum conical. Exostome brown or yellow; endostome pale, well developed; basal membrane high; cilia 2 or 3, appendiculate. Spores 10–15 µm diam. $n = 10$ (extra-Australian), *fide* R.Fritsch, *Bryophyt. Biblioth.* 40: 124 (1991). Fig. 39A–H.

Occurs in subtropical and tropical regions of W.A., Qld and N.S.W.; also in Vic.; grows on damp soil over rock often along streams and rivers. A highly variable, mainly pantropical species, widespread in Asia and Polynesia; also in Norfolk Is. and New Zealand. Map 161.

W.A.: King Creek Gorge, Kimberley, *A.C.Beauglehole 53580* (MEL). Qld: Danbulla Rd, Tinaroo Dam, Atherton Tableland, *J.R.Spence 5117* (NSW). N.S.W.: German Ck, Richmond R., *W.W.Watts 4410* (NSW). Vic.: Cumberland Falls, 23 Mar. 1956, *C.B.Kay* (MEL).

This species is characterised by the unusual laminal areolation, small, pyriform tubers and a weak costa. It is closely related to *G. inaequale* and *G. acuminatum*, both of which can be distinguished by the absence of gemmae.

3. **Gemmabryum australe** (Hampe) J.R.Spence & H.P.Ramsay, *Phytologia* 87: 65 (2005)

Bryum australe Hampe, *Icon. Musc.* t. 26 (1844). T: Swan R., W.A., *L.Preiss s.n.*; lecto: BM, *fide* H.Ochi, *J. Fac. Educ. Tottori Univ. Nat. Sci.* 21: 38 (1970); isolecto: MEL.

Bryum australe Hampe var. *minus* Hampe ex Sond., *Linnaea* 25: 714 (1853), *nom. nud.*

Bryum appressifolium Broth., *Oefvers. Förh. Finska Vetensk.-Soc.* 49: 175 (1898). T: New Zealand, *Bell s.n.*; syn: H-BR.

Illustrations: H.Ochi, *J. Fac. Educ. Tottori Univ. Nat. Sci.* 21: 39, fig. 21 (1970), as *B. appressifolium*; A.Eddy, *Handb. Malesian Mosses* 3: 133, fig. 419 (1996), as *B. australe.*

Dioicous. Plants in low golden or brown-green tufts. Stems to c. 15 mm tall. Rhizoids red-brown to brown. Leaves dense, suberect, rigid, triangular, more than 2 mm long and 0.8 mm wide, long-acuminate from a broad base, slightly plicate, rugose; margin strongly revolute from base to apex; marginal cells not strongly differentiated; costa stout, reddish, c. 100 µm wide at insertion, excurrent in a stiff hairpoint; upper laminal cells rhomboidal, small and incrassate, 30–40 × 10 µm (3–4: 1), parallel to costa; basal cells thin-walled, quadrate, brownish across insertion. Gemmae as rhizoidal tubers, large, red, in leaf axils or clustered around stem base, mostly > 125 µm long. Perichaetial leaves similar to but slightly smaller than vegetative

leaves. Setae 25–30 mm long, reddish. Capsules horizontal to pendulous, c. 3 mm long, to 1.5 mm wide, dark red-brown to purplish; urn short, wide-mouthed; neck tapering to seta, as long as urn; operculum high-domed, smooth. Peristome well developed; exostome teeth red, triangular, closely transversely barred internally, acute; endostome segments fully developed; basal membrane high, yellow; cilia 2 or 3, conspicuous, appendiculate. Spores 7–10 µm diam. Chromosome number not known. Fig. 43I–O.

Rare in W.A., Vic. and Tas.; grows in silty soil or soil over rock in open sites, e.g. river flats. Also in South America, Malesia (alpine western New Guinea) and New Zealand. Map 162.

W.A.: Rehabilitation Centre, W of Karnet, *D.H.Norris 25365* (PERTH). Vic.: Eastern Victoria, *G.K.Thomson* (MEL). Tas.: Mt Wellington, *R.A.Bastow 590* (MEL).

This species is characterised by the following suite of characters: stiffly erect, closely imbricate, setaceous leaves; incrassate upper cells; slightly plicate-rugose lamina; costa excurrent in a long hairpoint; leaf margins strongly recurved and lacking a border; and small, turgid, purple capsules with a large operculum.

4. Gemmabryum austrosabulosum (Catches. ex J.R.Spence & H.P.Ramsay) J.R.Spence & H.P.Ramsay, *Phytologia* 87: 65 (2005)

Bryum sabulosum Catches. ex J.R.Spence & H.P.Ramsay, *J. Adelaide Bot. Gard.* 17: 114 (1996), *nom. illeg.* (later homonym). T: Porongorups, W.A., Oct. 1867, *F.Mueller*; holo: MEL.

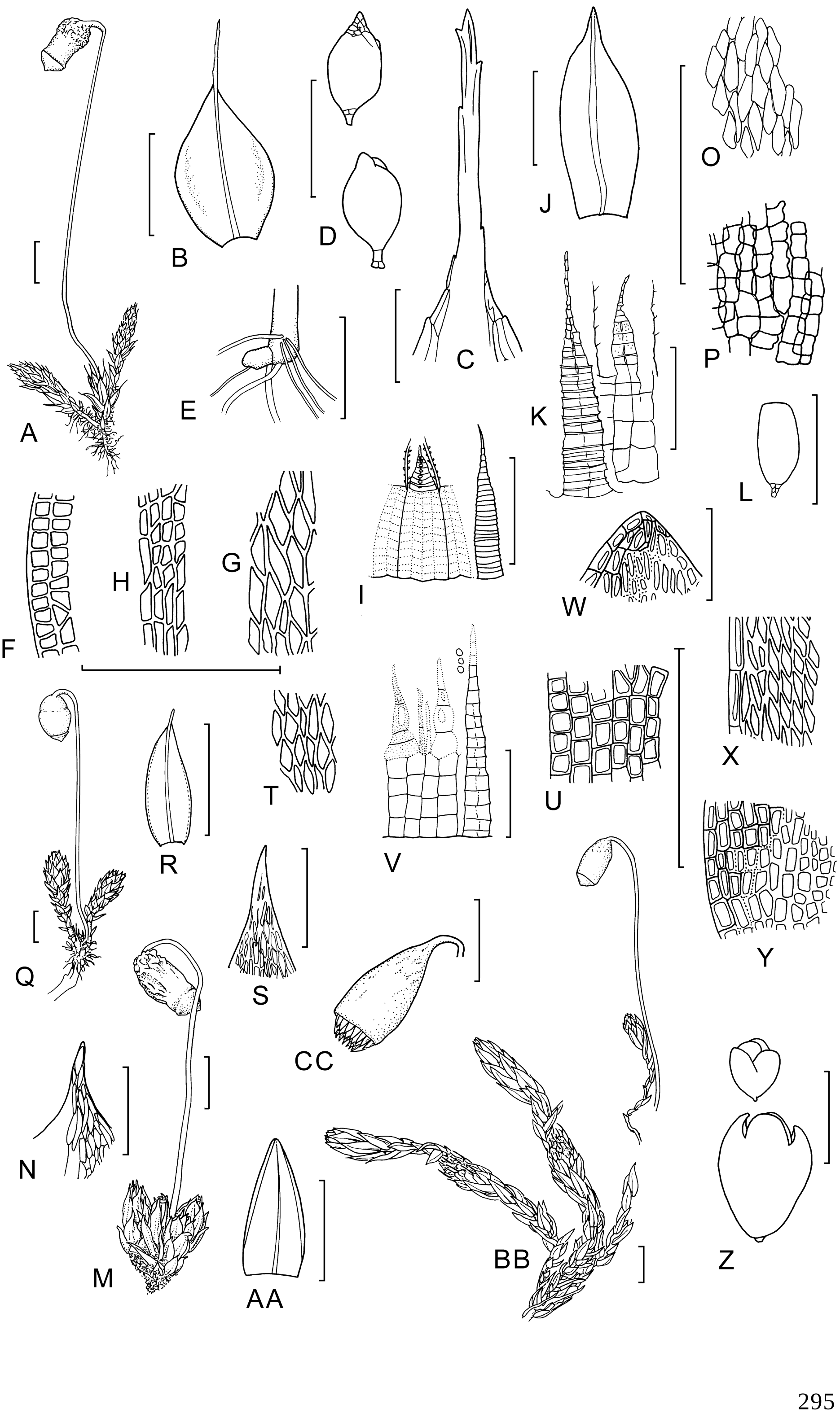
Illustrations: D.G.Catcheside, *Mosses of South Australia* 268, fig. 157 (1980), as *Bryum* sp.; J.R.Spence & H.P.Ramsay, *op. cit.* 115, fig. 4 (1996), as *Bryum sabulosum*.

Dioicous. Plants minute, 4–5 mm tall, brown or golden-green, often solitary among other mosses. Rhizoids brown. Leaves broadly ovate, tightly imbricate, 0.5–1.2 mm long, golden-brown, concave, acute, not cucullate; margin revolute almost to apex, entire, not bordered; costa short-excurrent, golden-brown; upper laminal cells hexagonal, 30–40 × 8–12 µm (3–4: 1), thick-walled; basal cells quadrate. Gemmae absent. Perichaetia on short basal shoots; perichaetial leaves somewhat larger than vegetative leaves. Setae long-exserted, 10–15 mm long, red, smooth. Capsules pendulous, small, 1.0–1.5 mm long, ovate, with a thick apophysis; neck smooth or somewhat corrugate when dry, abruptly contracting to the seta; operculum dome-shaped, short-apiculate. Peristome well developed; exostome teeth lanceolate, yellow-brown, smooth to papillose below; endostome segments c. 50–67% the length of the exostome, broadly perforated, with a high basal membrane; cilia 2, nodose. Spores 8–15 µm. Chromosome number not known. Fig. 41Q–V.

Endemic to W.A., S.A. and Vic. In W.A. it occurs most commonly on dry rock outcrops or in dry soil pockets on exposed rocks; elsewhere it is found in a range of habitats including sand dunes. Map 163.

W.A.: Yanchep Park, *G.G.Smith 285* (MEL); Petruder Rocks, *J.R.Spence 4152* (NSW). S.A.: Eyre Hwy, 18 km NW of Kyancutta, *A.C.Beauglehole 14960* (MEL). Vic.: near Nigretta Falls, Wannon R., near Hamilton, *D.G.Catcheside 77.148* (AD); Leigh Creek Gorge, 29 Oct. 1978, *I.G.Stone* (MEL).

Figure 41 (opposite). *Gemmabryum*. **A–I**, *G. eremaeum*. **A**, Habit with sporophyte (dry specimen); **B**, Leaf; **C**, Cells at leaf apex; **D**, Gemmae (axillary bulbils), **E**, Stem base with tuber; **F**, Marginal cells in mid-leaf; **G**, Mid-laminal cells; **H**, Basal laminal cells; **I**, Peristome: endostome with high basal membrane with central cilia and segment (left); exostome tooth (right) (A–I, *R.E.Grandison s.n.*, AD). **J–P**, *G. pachythecum*. **J**, Leaf; **K**, Peristome: exostome tooth (left); endostome basal membrane with cilia on either side of segment (right); **L**, Gemma (axillary bulbil); **M**, Habit with sporophyte (dry specimen); **N**, Cells at leaf apex; **O**, Mid-laminal cells; **P**, Basal laminal cells (J–P, lectotype). **Q–V**, *G. austrosabulosum*. **Q**, Habit with sporophyte (dry specimen); **R**, Leaf; **S**, Cells at leaf apex; **T**, Mid-laminal cells; **U**, Basal laminal cells; **V**, Peristome (Q–V, holotype). **W–CC**, *G. sullivanii*. **W**, Cells at leaf apex; **X**, Mid-laminal cells; **Y**, Basal laminal cells; **Z**, Gemmae (axillary bulbils); **AA**, Leaf; **BB**, Habit with sporophyte (dry specimen); **CC**, Capsule with peristome (W–CC, *W.A.Weymouth 27066*, AD). Scale bars: 1 mm for habit; 0.5 mm for leaves, 100 µm for cellular drawings. Drawn by L.Elkan.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This moss has probably been overlooked in the past because of its small size and a tendency to grow as scattered individuals in turfs of other species. Its most distinctive features are the golden-brown, tightly imbricate leaves and the small ovate capsule with a thick, almost smooth apophysis that is somewhat corrugated when dry. When sterile, *G. austrosabulosum* can only be separated from *G. exile* by the latter's production of bulbils and rhizoidal tubers, and its somewhat folded leaves when dry.

5. Gemmabryum cheelii (Broth.) J.R.Spence & H.P.Ramsay, *Phytologia* 87: 65 (2005)

Bryum cheelii Broth., *Proc. Linn. Soc. New South Wales* 41: 591 (1916). T: Shellharbour, N.S.W., 1 Oct. 1900, *E.Cheel 407*; holo: H-BR; iso: MEL, NSW.

[*Bryum muehlenbeckii auct. non* Bruch & Schimp.: H.Streimann & N.Klazenga, *Cat. Austral. Mosses* 34 (2002)]

Illustration: H.Ochi, *J. Fac. Educ. Tottori Univ. Nat. Sci.* 21: 40, fig. 22 (1970), as *Bryum cheelii*.

Dioicous. Plants medium-sized, red or with red tints, glossy, in tufts. Stems 10–25 mm tall. Rhizoids red to red-brown. Leaves medium or large, stiffly rigid and densely imbricate, ovate to oblong-lanceolate, 2.0–3.5 mm long, concave-carinate; apex acute, mucronate; margin recurved, serrulate at apex, unbordered; costa distinctly short-excurrent as a stout point; upper and middle laminal cells hexagonal-rhomboidal, 30–60 × 15–20 µm (3–4: 1), parallel to costa, incrassate; basal cells abruptly quadrate. Gemmae as rhizoidal tubers, rare, 100–400 µm wide, pale yellow-brown; cells not protuberant. Setae c. 20 mm long, red. Capsules pendulous, red to red-brown, pyriform, 3–4 mm long; operculum conical, papillose. Peristome well-developed; exostome teeth linear-lanceolate, subulate-acuminate, red-brown; apex hyaline, densely lamellose; endostome segments yellow, papillose, lanceolate, fenestrate; basal membrane high; cilia 2 or 3, well developed, appendiculate. Spores 8–12 µm diam. Chromosome number not known. Fig. 43P–V.

Endemic to W.A., S.A., N.S.W., Vic. and Tas.; grows on rock, often near streams. Map 164.

W.A.: Mt Frankland, Walpole-Nornalup Natl Park, *J.R.Spence 4221* (NSW). S.A.: Malinong, near Coomandook, *L.D.Williams* 218 (AD). N.S.W.: Wombeyan Caves, *H.Streimann 1615* (CANB). Vic.: Mt Pilot, near Beechworth, *D.G.Catcheside 69.250* (AD). Tas.: 11.2 km E of Launceston, *D.H.Norris 31706* (ALTA).

Gemmabryum cheelii appears to be related to the Northern Hemisphere *Bryum muehlenbeckii* Bruch & Schimp., but differs in its excurrent costa and much broader laminal cells. It is characterised as follows: glossy red or reddish colour that is particularly obvious in the apical leaves; plants with medium-sized, stiffly rigid, densely imbricate, unbordered ovate leaves with the upper laminal cells parallel to the costa; acute leaf apex with a short, stout point; rhizoidal gemmae rarely produced.

6. Gemmabryum chrysoneuron (Müll.Hal.) J.R.Spence & H.P.Ramsay, *Phytologia* 87: 66 (2005)

Bryum chrysoneuron Müll.Hal., *Bot. Zeitung (Berlin)* 9: 549 (1851). T: Swan R., W.A., *J.Drummond s.n.*; holo: BM.

Bryum duriusculum Hook.f. & Wilson, *in* J.D.Hooker, *Fl. Nov.-Zel*. 2: 84 ('1855') [1854]. T: New Zealand, *W.Wilson 357, 358, 359*; syn: BM.

Bryum suberythrocarpum Müll.Hal., *Bot. Zeitung (Berlin)* 14: 417 (1856). T: Porongorups, W.A., *F.Mueller*; holo: BM.

Bryum leptopelma Müll.Hal., *Hedwigia* 37: 88 (1898). T: Flat Rock Ck, North Shore, [Sydney], N.S.W., Aug. 1884, *T.Whitelegge 149*; holo: MEL; iso: H-BR, NSW.

Bryum lonchoneuron Müll.Hal., *Hedwigia* 37: 91 (1898). T: Richmond R., N.S.W., 1881, *Captain Stackhouse*; holo: MEL *n.v.*

Bryum microthecium Müll.Hal., *Hedwigia* 37: 95 (1898). T: Balls Head Bay, Sydney, N.S.W., Aug. 1884, *T.Whitelegge s.n.*; holo: MEL; iso: H-BR, NSW.

Bryum wattsii Broth., *Oefvers Förh. Finska Vetensk.-Soc*. 42: 101 (1900). T: Pearce's Ck, Richmond R., N.S.W., *W.W.Watts 1096, 1107*; syn: H-BR (*Watts 1096*); isosyn: NSW (*Watts 1096*); *Watts 1107* not seen. [originally published as *B. microthecium, nom. illeg.* (later homonym), republished as *B. wattsii*].

Bryum subpilosum Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 143 (1906), *nom. nud.* (in synon.). Based on: Sealers Cove, Vic., *F.Mueller* (MEL).

Illustrations: H.Ochi, *J. Fac. Educ. Tottori Univ. Nat. Sci.* 21: 25, fig. 10N–R (isotype of *Bryum leptopelma*); 26, fig. 11D–K (isotype of *B. microthecium*); fig. 11L–R (syntype of *B. wattsii*) (1970); D.G.Catcheside, *Mosses of South Australia* 274, fig. 162 (1980), as *Bryum chrysoneuron*.

Dioicous. Plants in loose or dense tufts, yellowish green to yellowish brown, often tinged red and glossy. Stems slender, 5–15 mm tall, with densely leafy innovations. Rhizoids red to red-brown. Leaves ovate-lanceolate to lanceolate, sometimes narrow, somewhat concave, 1.0–1.5 mm long, erect or suberect whether wet or dry; apex acute to acuminate; margin plane or revolute to mid-leaf, without a border, smooth to finely serrulate above; costa strong, long-excurrent, golden-yellow; laminal cells rhomboidal, mostly 40–60 × 10–15 µm wide (4–6: 1), rather incrassate, irregular in shape and often very long near margin; cells in lower quarter of leaf short-rectangular across leaf base but quadrate at margin. Gemmae as rhizoidal tubers, common, large, at least some > 500 µm long, red; cells protuberant. Perichaetial leaves with a long-excurrent costa. Setae exserted, 15–40 mm long, purple-red. Capsules 2–3 mm long, cernuous or pendulous, brown or reddish when mature, clavate, long-tapered at base, widest at mouth; operculum convex, apiculate. Exostome and endostome of similar length; exostome of 16 yellow teeth with hyaline borders and numerous lamellae on inner face; endostome with a high basal membrane; segments gaping widely; cilia 2, sometimes joined, variably appendiculate. Spores 10–13 µm, smooth. Chromosome number not known. Fig. 39I–O.

Occurs in all States and Territories; rather common on rocks and on soil over rock, often near the sea. Also in New Caledonia, Fiji, New Zealand and Macquarie Is. Map 165.

W.A.: road to Ranger Hut, Two Peoples Bay Nature Reserve, *J.R.Spence 4194* (NSW). N.T.: Mt Giles, *P.K.Latz 66146 p.p.* (AD). Qld: Mt Bellenden Ker, *I.G.Stone 12142* (MEL). N.S.W.: Cambewarra, *C.Harris 296* (MEL, NSW). A.C.T.: near Uriara Crossing, *D.G.Catcheside 64.83* (AD). Vic.: Eastern Victoria, *G.K.Thomson s.n.* (MEL 29852). Tas.: Mt Wellington, Oct. 1886, *R.A.Bastow* (MEL).

A distinctive and beautiful species characterised by glossy, golden-green leaves each with a long hairpoint, and exceptionally large red tubers with protuberant cells. The tubers resemble miniature red golfballs. Capsules are common.

7. **Gemmabryum clavatum** (Schimp.) J.R.Spence & H.P.Ramsay, *Phytologia* 87: 66 (2005)

Pohlia clavata Schimp., *Ann. Sci. Nat. Bot.*, sér. 2, 6: 148 (1836); *Bryum clavatum* (Schimp.) Müll.Hal., *Syn. Musc. Frond.* 1: 292 (1848). T: New Zealand, *Logan H 2813*; syn: BM.

Bryum clavatum Hook.f. & Wilson, *in* J.D.Hooker, *Fl. Nov.-Zel.* 2: 84 (‘1855’) [1854], *nom. illeg.* (later homonym). T: New Zealand, *Logan s.n.*; syn: BM.

Bryum erythrocarpoides Müll.Hal. & Hampe, *Linnaea* 26: 495 (1853). T: Lofty Ra., S.A., Oct. 1850, *F.Mueller s.n.*; holo: BM; iso: MEL.

Bryum curvicollum Mitt., *Handb. New Zealand Fl.* 442 (1867). T: New Zealand, *Travers s.n.*; iso: K.

Bryum curvicollum Mitt. var. *extenuatum* Hook.f. & Wilson, *Handb. New Zealand Fl.* 442 (1867). T: New Zealand, *W.Wilson*; holo: BM.

Bryum laevigatulum Broth., *Oefvers. Förh. Finska Vetensk.-Soc.* 40: 176 (1898). T: Tas., *W.A.Weymouth s.n.*; holo: H-BR.

Bryum filicaule Broth., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 132 (1906), *nom. nud.* (in synon.). T: see *B. filarium* (below); the specimen cited there was named *B. filicaule in sched.*

Bryum suberythrocarpulum Broth. ex Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 139 (1906), *nom. nud.* (in synon.). Based on: Shaws Bay, Richmond R., N.S.W., Oct 1896, *W.W.Watts 1044, 1047, 1057*; Wardell, Oct. 1896, *W.W.Watts 1154*; Wilsons Ck, Aug. 1898, *W.W.Watts s.n.* (all at NSW).

Bryum sublaevigatum Broth. ex Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 143 (1906), *nom. nud.* (in synon.). Based on: Weedallion Mtn, near Young, N.S.W., 19 Aug. 1903, *W.W.Watts 7237* (NSW).

Bryum filarium Broth., *Proc. Linn. Soc. New South Wales* 41: 590 (1916). T: Skinners Head, Richmond R., N.S.W., *W.W.Watts 4127*; holo: H-BR; iso: BM, NSW.

Bryum kiamae Broth., *Proc. Linn. Soc. New South Wales* 41: 592 (1916). T: Kiama, N.S.W., 1906, *W.Forsyth 381*; holo: H-BR; iso: NSW.

Bryum subcurvicollum Broth., *Proc. Linn. Soc. New South Wales* 41: 590 (1916). T: Apsley Falls, N.S.W., *W.Forsyth 749*; holo: H-BR; iso: MEL, NSW.

Illustrations: H.Ochi, *J. Fac. Educ. Tottori Univ. Nat. Sci.* 21: 29, fig. 13A–H (isotype of *B. erythrocarpoides*); fig. 13I–L (syntype *Watts 105*, as *B. diversinerve*); 30, fig. 14A–G (type of *B. kiamae*); 32, fig. 15A–G (type of *B. subcurvicollum*); fig. 15H–M (syntype of *B. clavatum*); 33, fig. 16 (type of *B. filarium*) (1970); R.D.Seppelt, *The Moss Flora of Macquarie Island* 99, fig. 37 (2004), as *Bryum clavatum.*

Dioicous. Plants small to comparatively robust, green to bronze or dull green to reddish brown, often tufaceous, sometimes in dense cushions, often mixed with other mosses, glossy, often tinged with crimson. Stems variable in height, usually less than 10 mm, but leafless stems can reach 5 cm or more in wet habitats. Rhizoids brown, forming tomentum. Leaves equidistant on stem, lanceolate, imbricate, to 2–3 mm long, weakly concave, acute, usually distinctly bordered by 1–3 rows of narrow incrassate cells that are often reddish or brown; border weak or absent above; upper margin ±entire; costa strong, reddish or brown, short-excurrent as a rigid reddish or brownish arista; upper laminal cells narrowly rhomboidal, incrassate, 40–80 × 10–15 µm (3–5: 1), oblique to costa; basal laminal cells short-rectangular to quadrate, usually with red walls, abruptly differentiated from upper cells. Tubers occasional on rhizoids, red-brown, irregularly globose, 150–400 µm long. Perichaetia and perigonia on very short stems with comal tufts. Setae 10–20 (–40) mm long. Capsules large, elongate-clavate, subpendulous, 2–5 mm long, distinctly curved when mature, highly variable in shape, tapered to a slender apophysis, 2–4 mm long, red-purple; operculum conical. Peristome: basal membrane high; cilia variable from rudimentary to fully developed, appendiculate. Spores large, 19–25 µm diam., finely papillose. n = 11 (10 + m), *fide* H.P.Ramsay & J.R.Spence, *J. Hattori Bot. Lab*. 80: 255 (1996). Fig. 40A–G.

Occurs in S.A., Qld, N.S.W., A.C.T., Vic. and Tas.; grows in open situations, e.g. stream banks and wet, often calcareous rock or soil. Also in New Guinea, Lord Howe Is., the South Pacific, Macquarie Is., New Zealand and South America. Map 166.

S.A.: Waterfall Gully, Adelaide, *D.G.Catcheside 77.254* (AD). N.S.W.: Oakey Ck, NNE of Boorowa, *H.Streimann 5678* (AD). A.C.T.: Paddys Ck, Mt Gibraltar, *D.G.Catcheside 64.25* (AD). Vic.: Lower Glenelg R., *A.C.Beauglehole 3000* (MEL). Tas.: Chimney Pot Rd, *D.A. & A.V.Ratkowsky B344* (MEL).

This moss is characterised by its mostly green colour, short-excurrent costa, bordered lower portions of leaves, and elongate purplish capsules. Rhizoidal tubers are only occasionally produced. It can be distinguished from *G. apiculatum* which has elongate, thin-walled leaf cells, distinctly quadrate alar cells, unbordered leaves and small pyriform tubers.

8. **Gemmabryum coarctatum** (Müll.Hal.) J.R.Spence & H.P.Ramsay, *Phytologia* 87: 66 (2005)

Bryum coarctatum Müll.Hal., *Syn. Musc. Frond.* 1: 312 (1849); *Brachymenium coarctatum* (Müll.Hal.) Bosch & Sande Lac., *Bryol. Javan.* 1: 140, t. 115 (1860). T: Ost Java, bei Jogjakarta, [Indonesia], *Junghuhn*; holo: *n.v.*

Illustration: A.Eddy, *Handb. Malesian Mosses* 3: 171, fig. 446A–D (1996), as *Brachymenium coarctatum*.

Dioicous. Plants small, to 10 mm tall, highly glossy, green, yellowish green or silver-green (due to hyaline leaf tips), somewhat comose. Rhizoids brown to red-brown, sparse. Leaves small, 1–2 mm long, slightly contorted and twisted when dry, ovate or ovate-lanceolate; apex acute or somewhat rounded; margin finely serrulate above; costa excurrent, hyaline; comal leaves larger than lower stem leaves, with a longer arista; upper laminal cells rhomboidal, 20–50 × 10–12 µm, with thin or slightly thickened walls; marginal cells often longer and narrower, forming a rather distinct border in the upper half, weak or absent in the lower half; basal cells short-rectangular. Gemmae as pale brown irregularly shaped stem tubers; leaf axil bulbils and rhizoidal tubers unknown. Setae 10–30 mm long, brown to red. Capsules narrowly oval-cylindrical, erect, 1.5–2.5 mm long; mouth wide; apophysis distinct, rugose; operculum tall, conical. Peristome reduced; exostome teeth 16, orange-brown; endostome 50–67% the height of the exostome teeth; segments often vestigial; cilia vestigial or absent. Spores 10–15 µm diam. Chromosome number not known.

Known from subtropical and tropical woodland in W.A., N.T. and Qld; grows on seasonally wet soil, or on soil over rocks or walls, often on calcareous substrata. Also scattered throughout Malesia and Polynesia. Map 167.

W.A.: Drysdale River Natl Park, E Kimberley, *K.F.Kenneally 4205* (PERTH). N.T.: Cutta Caves, S of Katherine, *I.G.Stone 23332* (MEL). Qld: Wallenden Tower, Chillagoe, *I.G.Stone 21742* (MEL).

Australian collections lack sporophytes. However, the strong, long-excurrent, hyaline costa, recurved leaf margin, distinct upper leaf border, ovate-lanceolate, loosely set and somewhat shrunken leaves, rectangular basal laminal cells and dioicous sexuality are characteristic. Most Australian specimens have large and very unusual, irregularly shaped gemmae as pale brown stem tubers, a feature not previously reported for this species and only rarely reported for the family Bryaceae (El-Saadawi & Zanaty, *J. Hattori Bot. Lab.* 68: 285–291, 1990) and for *G. eremaeum* (J.R.Spence & H.P.Ramsay, *J. Adelaide Bot. Gard.* 17: 112, 1996). Although we have named the Australian collections based on gametophytic resemblances to specimens from elsewhere, it is possible that these represent a distinct species with a different sporophyte to *G. coarctatum*.

9. Gemmabryum coronatum (Schwägr.) J.R.Spence & H.P.Ramsay, *Phytologia* 87: 66 (2005)

Bryum coronatum Schwägr., *Sp. Musc. Frond.*, Suppl. 1, 2: 103 (1816). T: “In Guiana, Jamaica”, *C.Richard*; syn: *n.v.*

Bryum brevicaule Hampe, *Linnaea* 36: 518 (1870), *nom. illeg.* (later homonym). T: *n.v.*

Bryum subatropurpureum Müll.Hal., *Linnaea* 37: 147 (1871). T: Brisbane R., Qld, 1864, *A.Dietrich*; iso: BM.

Bryum macropelma Müll.Hal., *Linnaea* 37: 149 (1872). T: “Nova Hollandea occidentalis” [W.A.], *L.Preiss 2464*; Porongorups, W.A., *F.Mueller s.n.*; syn: BM.

Bryum angeiophyllum Müll.Hal., *Genera Musc. Frond.* 208 (1901), *nom. nud.* (in synon.). Based on: Hamilton, Brisbane, Qld, Aug. 1887, Apr. 1888, *C.J.Wild* (BRI).

Illustrations: H.Crum & L.E.Anderson, *Mosses of Eastern North America* 1: 570, fig. 264 (1981); A.Noguchi, *Illustrated Moss Flora of Japan* 2: 483, fig. 212 (1988); A.Eddy, *Handb. Malesian Mosses* 3: 123, fig. 412A–G (1996), all as *Bryum coronatum*.

Dioicous. Plants in dense tufts, yellowish green, not blackish below. Stems 5–15 mm long. Rhizoids brown to red-brown. Leaves imbricate, erect-spreading when moist, not or slightly contorted when dry, triangular or lanceolate, to 2 mm long, plane or weakly concave; apex acute to acuminate, not cucullate; margin recurved in lower 50–67%, entire to weakly serrulate above; costa red-brown, excurrent into a long hairpoint; median laminal cells rhomboidal to elongate-hexagonal, 30–50 × 8–12 µm (3–5: 1), thin-walled; marginal cells narrowly rectangular, thin-walled, forming an indistinct border; lower laminal cells quadrate. Gemmae as axillary bulbils, solitary, green or brown-green, with distinct leafy primordia. Setae 10–20 mm long, reddish brown. Capsules cernuous to pendulous, oblong, 1.2–2.5 mm long, reddish brown at maturity, somewhat glossy; neck wider than urn, thickly corrugate to warty when dry, abruptly narrowed to the seta; operculum dome-shaped, minutely apiculate. Peristome well developed; exostome teeth c. 500 µm long, faintly bordered, orange-red below, hyaline with large papillae above; endostome segments with large perforations; cilia 2 or 3, well developed, strongly appendiculate, slightly shorter than segments. Spores 10–15 µm diam. Chromosome number not known for Australia; n =10, 11 (10 + m), 20, *fide* R.Fritsch, *Bryophyt. Biblioth.* 40: 1–326 (1991). Fig. 42H–N.

Occurs in W.A., Qld and N.S.W. on damp soil, rock and old wood in disturbed places. A pantropical to subtropical species in North and South America, Africa, India, Malesia, Japan, New Caledonia, Lord Howe Is. and New Zealand. Map 168.

Qld: Malanda, *W.W.Watts Q505* (NSW); Old State Forest Rd, N from Builan, *I.G.Stone 22788* (MEL). N.S.W.: Richmond R., *W.W.Watts 5231* (NSW).

This moss can be separated from other Australian species with a thickly corrugated capsule neck by the presence of leafy primordia on the bulbils, and recurved leaf margins. However, in the absence of capsules, it is difficult to distinguish this from sterile *G. dichotomum*.

10. Gemmabryum crassum (Hook.f. & Wilson) J.R.Spence & H.P.Ramsay, *Phytologia* 87: 66 (2005)

Bryum crassum Hook.f. & Wilson, *in* J.D.Hooker, *Fl. Nov.-Zel*. 2: 86 ('1855') [1854]. T: Manukau Bay, New Zealand, *W.Colenso 136*; iso: BM.

Bryum austroalpinum Müll.Hal., *Hedwigia* 37: 99 (1898). T: Ballarat, Vic., 1875, *G.Day*; holo?: MEL (not located); iso: BM, H.

Illustrations: G.O.K.Sainsbury, *Bull. Roy. Soc. New Zealand* 5: 280, pl. 40, fig. 1 (1955), as *Bryum crassum*; H.Ochi, *J. Fac. Educ. Tottori Univ. Nat. Sci*. 21: 41, fig. 23A–E (isotype of *B. crassum*), fig. 23F–H (isotype of *B. austroalpinum*) (1970).

Dioicous. Plants loosely tufted, green, yellow-green or brown-green, becoming brown or reddish brown below, dull or glossy, 5–20 mm tall. Stems simple or branched with short innovations, often in comal tufts. Rhizoids forming a brown or brick-red tomentum. Leaves comose, interrupted-comose on longer stems, appressed, closely imbricate, little-altered when dry, 1.5–2.0 mm long, rather thick, strongly concave, ovate-oblong, broadly acute; margin recurved to near apex, entire or slightly denticulate, unbordered; costa robust, yellow-brown, projecting dorsally, distinctly percurrent or short-excurrent with a smooth mucro; upper and sometimes median laminal cells oblique to costa, incrassate, 25–60 × 12–20 µm wide (2–4: 1), irregular in shape in upper part of lamina, somewhat rounded at ends; basal cells subquadrate. Gemmae absent. Setae 20–25 mm long, curved at apex. Capsules horizontal to pendulous, oblong or clavate, to 2 mm long, brown; neck short and abruptly narrowed to the seta, with a very wide mouth when empty; operculum large, conical and apiculate. Exostome teeth distant, orange-red, hyaline above on dorsal face, finely papillose, with a zig-zag median line; endostome segments white, papillose, from a high basal membrane, widely split; cilia 1 or 2, long, appendiculate. Spores 8–12 µm diam. Chromosome number not known. Fig. 40H–O.

Occurs in N.S.W., Vic. and Tas.; grows on damp to dry sand or rock usually in open situations. Also in New Zealand. Map 169.

N.S.W.: Yarrangobilly Caves, 1906, *W.W.Watts* (NSW). Vic.: Toorongo area, Mt Baw Baw, *S.Tilley s.n.* (MEL). Tas.: Derwent to Queenstown, *I.G.Stone 3441*, *3475* (MEL).

This moss is characterised by the strongly imbricate leaves in comal tufts, interrupted in longer stems, laminal cells arranged obliquely to the costa, these being markedly incrassate with rounded end walls, and a short-excurrent costa with a smooth mucro.

11. Gemmabryum dichotomum (Hedw.) J.R.Spence & H.P.Ramsay, *Phytologia* 87: 66 (2005)

Bryum dichotomum Hedw., *Sp. Musc. Frond.* 183 (1801). T: New Zealand, *J.Banks*; *n.v.*

Bryum annulatum Hook.f. & Wilson, *Fl. Antarct*. 1: 134 (1844). T: Mt Ararat, Vic., July 1875, *D.Sullivan s.n.*; holo: MEL.

Bryum pimpamae Müll.Hal., *Hedwigia* 37: 90 (1898). T: Pimpama, Qld, Aug. 1887, *C.Wild*; syn: H-BR.

Bryum brachytheciella Müll.Hal., *Hedwigia* 37: 91 (1898). T: Mossmans Bay, Sydney, N.S.W., Sept. 1884, *T.Whitelegge s.n.*; holo: MEL; iso: H-BR, NSW.

Bryum argillicola Broth., *Oefvers. Förh. Finska Vetensk.-Soc*. 42: 118, 119 (1899). T: Port Cygnet, Lymington, Tas., *W.A.Weymouth 1846*; holo: H-BR.

Bryum balanoides Taylor ex Broth., *Nat. Pflanzenfam.* I, 3: 588 (1904). T: Swan R., W.A., *J.Drummond*; holo: MEL.

Bryum subcupulatum Müll.Hal. ex Rodway, *Pap. & Proc. Roy. Soc. Tasmania* 1913: 190 (1914). T: Tas., locality unknown; holo: *n.v.*; iso: H-BR.

Bryum coronatoaffine Müll.Hal. ex F.M.Bailey, *Syn. Queensland Fl.* Suppl. 1: 67 (1886), *nom. nud.* Based on: Brisbane R., Qld, *H.Tryon s.n.* (BRI, MEL).

Bryum viridissimum Broth. ex F.M.Bailey, *Queensland Bot. Bull.* 2: 24 (1891), *nom. nud.* Based on: Brisbane, Qld, *H.Tryon 802* (BRI).

Illustrations: A.Eddy, *Handb. Malesian Mosses* 3: 141, fig. 427 (1996), as *Bryum bicolor*; H.Streimann, *The Mosses of Norfolk Island* 31, fig. 10 (2002), as *Bryum dichotomum*; R.D.Seppelt, *The Moss Flora of Macquarie Island* 101, fig. 38 (2004), as *Bryum dichotomum*.

Dioicous. Plants in tufts, brown to yellowish green, often rather glossy. Stems short, erect, 5–20 mm tall. Rhizoids brown to red-brown. Leaves imbricate, 0.75–1.50 mm long, erecto-patent, little-altered but somewhat folded lengthwise when dry, ovate-lanceolate to lanceolate, acuminate, weakly concave; margin plane, rarely recurved near the base, entire; costa percurrent or excurrent in a rigid point, yellow; laminal cells with firm to incrassate walls, hexagonal to rhomboidal in mid-leaf, 35–50 × 10–12 µm, becoming rhomboidal, then narrowly-rectangular, to 80 µm long at margin of upper half of leaf, but not forming a distinct border; basal cells quadrate or short-rectangular. Gemmae as bulbils, numerous in upper leaf axils (1 per axil), 0.3–1.0 mm long, 0.1–0.3 mm wide, bearing rudimentary leaves in upper 25–50%; red globose rhizoidal tubers sometimes present. Setae exserted, 5–15 mm long, reddish. Capsules cernuous to pendulous, oblong-elliptical, 1.5–2.0 mm long, pale to dark brown, the apophysis tapering to the seta, wrinkled when dry; operculum low-conical. Peristome well developed; exostome teeth yellow; endostome with a basal membrane less than half the height of the exostome; segments with narrow slits; cilia (1–) 2 (–3), appendiculate. Spores 12–14 µm diam. *n* =10, *fide* H.P.Ramsay & J.R.Spence, *J. Hattori Bot. Lab*. 80: 259 (1996). Fig. 42X–EE, Plate 40.

Occurs in all States and Territories. A common species on damp and often clay soils, sometimes on rock, often forming extensive turfs over wet soil in the early stages of colonisation. Also widespread in the Southern Hemisphere, incl. South America, Antarctica, Lord Howe Is., Norfolk Is., Macquarie Is. and New Zealand. Map 170.

W.A.: Petruder Rocks, c. 30 km E of Pithara, *J.R.Spence 4144* (NSW). N.T.: Stanley Chasm, *D.G.Catcheside 76.318* (AD). S.A.: banks of Glenelg R., *D.G.Catcheside 55.118* (AD). Qld: Upper Mobray, *coll. unknown* (CANB 362206). N.S.W.: Barren Grounds, *D.G.Catcheside 16044* (NSW). A.C.T.: Australian National Botanic Gardens, Canberra, *R.G.Catcheside 17264* (NSW). Vic.: Annuello, *A.C.Beauglehole 57298* (MEL). Tas.: Mt Wellington, *A.V.Ratkowsky H557* (AD).

Bulbils with rudimentary leaves are usually abundant and conspicuous. The capsule has a slender, smooth or only slightly corrugated neck tapering to the seta, narrowly waisted below the mouth, with the neck concolorous with the rest of the capsule. By contrast, in *G. pachythecum* and *G. coronatum* the neck is strongly corrugated and darker. *Gemmabryum coronatum* differs from *G. dichotomum* in having the neck abruptly contracted to the seta; moreover, the leaves are more narrowly ovate-lanceolate to triangular with strongly recurved margins.

Gemmabryum dichotomum has been synonymised by Ochi (*J. Fac. Educ. Tottori Univ. Nat. Sci*. 34(2): 53, 1985) with *Bryum* [*Gemmabryum*] *bicolor*. The two taxa are widely distributed in Europe, America, India, Malesia and Oceania, but there is much confusion in the synonymy.

This species includes *Bryum* “sp. E” of Catcheside (1980); see Spence & Ramsay (1996).

12. Gemmabryum eremaeum (Catches. ex J.R.Spence & H.P.Ramsay) J.R.Spence & H.P.Ramsay, *Phytologia* 87: 66 (2005)

Bryum eremaeum Catches. ex J.R.Spence & H.P.Ramsay, *J. Adelaide Bot. Gard*. 17: 112 (1996). T: Mirra Mitta Bore, between Maree and Birdsville, S.A., Sept. 1978, *R.E.Grandison s.n.*; holo: AD.

Illustrations: D.G.Catcheside, *Mosses of South Australia* 267, fig. 156 (1980), as *Bryum* sp. C; J.R.Spence & H.P.Ramsay, *op. cit.* 113, fig. 3 (1996), as *Bryum eremaeum*.

Dioicous. Plants in short dense tufts, reddish green, 4–6 mm tall, often appearing hoary due to hyaline hairpoints. Rhizoids red to red-brown. Leaves broadly ovate and weakly concave, 1.5–2.0 mm long; margin revolute at least to mid-leaf, entire to finely serrulate, unbordered; costa strong, red-brown; hairpoint relatively long, hyaline and toothed; upper laminal cells elongate, hexagonal-rhomboidal, 30–50 × 10–15 µm (3–4: 1); basal cells quadrate, often wider than long in alar region. Gemmae as bulbils and stem tubers; bulbils common in leaf axils of sterile shoots, often more than 1 per axil, broadly ellipsoidal, with 2 short peg-like primordia separated by a groove; stem tubers sometimes present, budding off from the base of underground portions of stems, white to pale tan. Perichaetia on short basal shoots; perichaetial leaves larger than vegetative leaves. Setae long-exserted, c. 15 mm long, smooth, red-brown. Capsules ovate, 1.5–2.0 mm long, somewhat tapered to the seta, brown

or red; apophysis wrinkled when dry, somewhat inflated, abruptly contracted to the seta; operculum dome-shaped, apiculate. Peristome well developed; exostome teeth lanceolate, yellowish brown, papillose below, hyaline near tips; endostome segments 67–75% the length of the exostome teeth, broadly perforated; cilia 2 or 3, appendiculate. Spores 8–15 µm diam. Chromosome number not known. Fig. 41A–I.

This endemic species occurs on soil in arid regions of S.A., south-western N.S.W. and north-western Vic. It should also be looked for in south-western W.A. Map 171.

S.A.: Mirra Mitta Bore, *D.G.Catcheside B1, B4, B6* (AD). N.S.W.: near Euston, *D.G.Catcheside 74.86* (AD). Vic.: Kiata Lowan Sanctuary, *A.C.Beauglehole 57179* (MEL).

Documented by Catcheside (1980) as *Bryum* “species C”, this is related to the more widespread *G. pachythecum*. However, the bulbils of *G. eremaeum* have small, peg-like primordia at the apex, separated by a groove, while those of G. *pachythecum* are smooth and lack primordia. The distinctive, long, white and toothed leaf hairpoint of *G. eremaeum* is very different from the shorter, brown, golden or reddish hairpoint of *G. pachythecum.*

13. Gemmabryum exile (Dozy & Molk.) J.R.Spence & H.P.Ramsay, *Phytologia* 87: 67 (2005)

Bryum exile Dozy & Molk., *Ann. Sci. Nat. Bot.*, sér. 3, 2: 300 (1844); *Brachymenium exile* (Dozy & Molk.) Bosch & Sande Lac., *Bryol. Javan.* 1: 139 (1860). T: Java; *n.v.*

Illustrations: D.G.Catcheside, *Mosses of South Australia* 249, fig. 144 (1980); A.Eddy, *Handb. Malesian Mosses* 3: 172, fig. 447 (1996); H.Streimann, *The Mosses of Norfolk Island* 16, fig. 4 (2002), all as *Brachymenium exile*.

Dioicous. Plants very small, to 4–10 mm tall, in dense tufts, green, yellowish or brownish, distinctly glossy; innovations string-like; female stems very short. Rhizoids pale brown to red-brown, sparse. Leaves imbricate to somewhat folded inward along costa, erect to suberect, very small, to 0.5–1.2 mm long, ovate, somewhat concave; apex acute; margin plane above, sometimes narrowly revolute on one or both sides below on large leaves, entire above or with a few inconspicuous teeth; costa stout, yellowish, excurrent as a short stiff or, rarely, long hairpoint; upper laminal cells rhomboidal-hexagonal, 20–50 × 8–10 µm, with thin to slightly thickened walls; marginal cells often longer and narrower, but not forming a distinct border; basal cells quadrate. Gemmae as leafy axillary bulbils, solitary on sterile stems; rhizoidal tubers occasionally present, small-pyriform, 100–200 µm, red-brown. Setae 15–18 mm long, reddish. Capsules erect, obovoid to short-ovate, to 2 mm long, with a well-defined rugose apophysis; operculum red, low-conical. Exostome teeth 16, yellow to orange-brown, lanceolate, trabeculate on external face, transversely barred internally, finely uniformly papillose throughout; apices hyaline; endostome variable; basal membrane low; segments reduced, split at apex; cilia absent. Spores 8–10 µm diam. Chromosome number not known. Plate 36.

Occurs in W.A., N.T., Qld, N.S.W. and A.C.T.; usually on soil or rock, often calcareous. Also pantropical and subtropical in South America, Africa, SE Asia, Malesia, the Hawaiian Is., Norfolk Is. and New Zealand. Map 172.

W.A.: Perth, *R.Wyatt & A.Stoneburner 3862* (PERTH). Qld: Tinaroo Perimeter Rd, NE of Atherton, *H.Streimann 16972* (CANB). A.C.T.: Australian National Botanic Gardens, Canberra, *H.Streimann 10681* (CANB).

The dioicous *G. exile* has imbricate, ovate leaves with predominantly plane margins. Some dry collections have the leaves regularly folded inward along the costa, giving the stem a very slender, string-like appearance. By contrast, the synoicous *G. indicum* has somewhat shrunken and contorted leaves with strongly revolute margins. *Gemmabryum austrosabulosum* is very similar, and sterile specimens cannot always be reliably separated in the absence of gemmae in *G. exile*. *Gemmabryum exile* produces leafy bulbils in leaf axils and often has rhizoidal tubers, whereas *G. austrosabulosum* always lacks gemmae. A few collections of *G. exile* from arid regions of northern Australia have a long-excurrent costa.

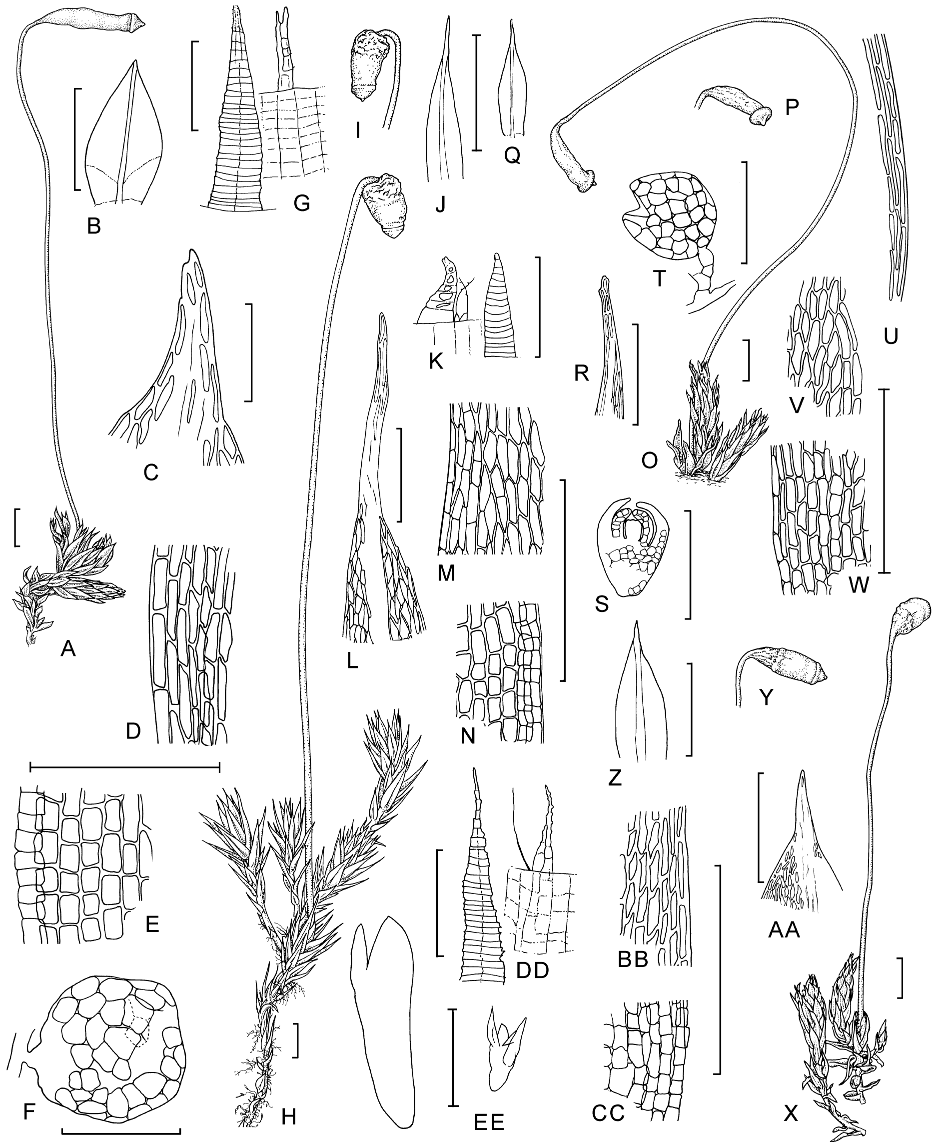

Figure 42. *Gemmabryum*. **A–G**, *G. subapiculatum*. **A**, Habit with sporophyte (dry specimen); **B**, Leaf; **C**, Cells at leaf apex; **D**, Upper laminal cells; **E**, Basal laminal cells; **F**, Rhizoidal tuber; **G**, Peristome: exostome tooth (left); endostome with basal membrane and segment (right) (A–G, *W.B.Schofield 98262*, NSW). **H–N**, *G. coronatum*. **H**, Habit with sporophyte (dry specimen); **I,** Capsule; **J**, Leaf; **K**, Peristome: endostome with basal membrane segment and cilium (left); exostome tooth (right); **L**, Cells at leaf apex; **M**, Mid-laminal cells; **N**, Basal laminal cells (H–N, *H.P.Ramsay R174*, NSW). **O–W**, *G. tenuisetum*. **O**, Habit with sporophyte (dry specimen); **P**, Capsule; **Q**, Leaf; **R**, Cells at leaf apex; **S**, Rhizoidal tuber; **T**, Axillary bulbil; **U**, Marginal cells at mid-leaf; **V**, Mid-laminal cells; **W**, Basal laminal cells (O–W, *I.G.Stone 1719*, MEL). **X–EE**, *G. dichotomum*. **X**, Habit with sporophyte (dry specimen); **Y**, Capsule; **Z**, Leaf; **AA**, Cells at leaf apex; **BB**, Mid-leaf cells; **CC**, Basal laminal cells; **DD**, Peristome: exostome tooth (left); endostome basal membrane with cilium and segment (right); **EE**, Axillary bulbils (X–EE, *H.P.Ramsay 22/73*, NSW). Scale bars: 1 mm for habit; 0.5 mm for leaves, 100 µm for cellular drawings. Drawn by L.Elkan.

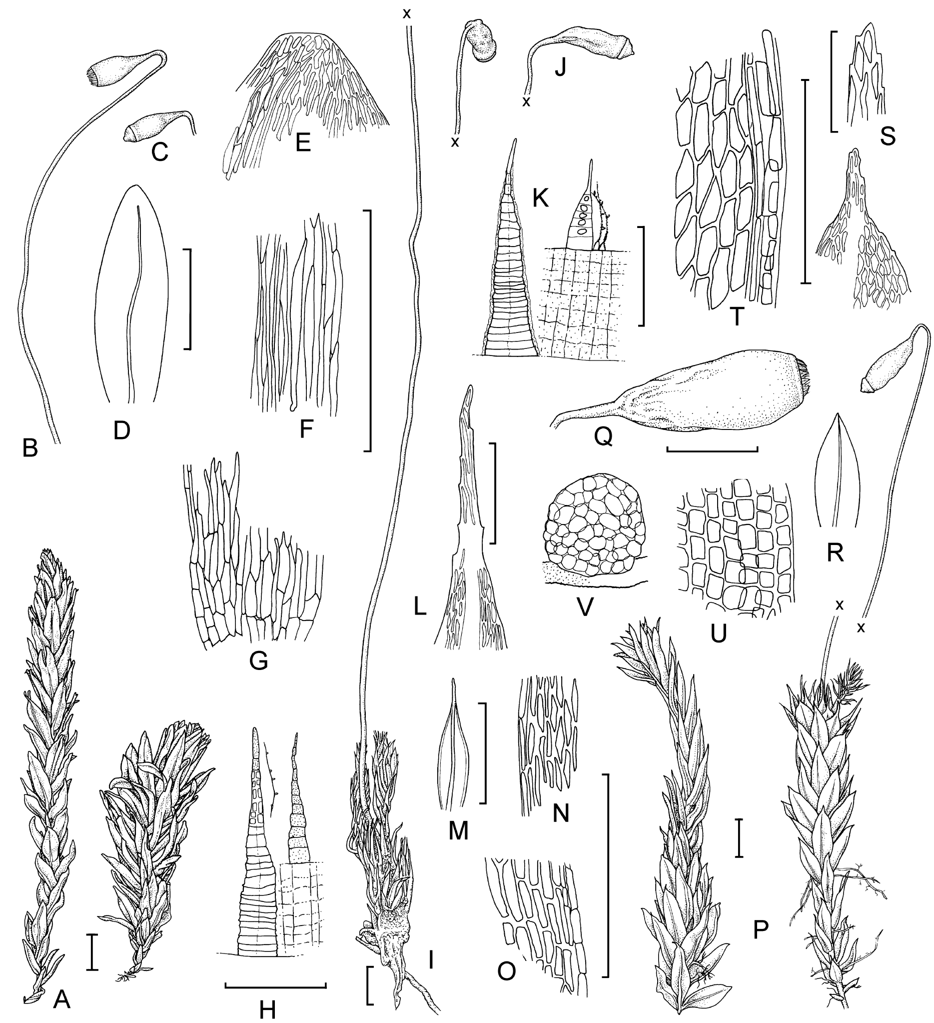

Figure 43. Bryaceae. **A–H**, *Ochiobryum blandum*. **A**, Habit of dry specimens (left, *M.Mueller 1795*, MELU; right, *A.E.Orchard 1931*, AD); **B**, Seta and capsule showing peristome; **C**, Capsule with operculum (B, C, *H.P.Ramsay 76/84*, NSW); **D**, Leaf; **E**, Cells at leaf apex; **F**, Mid-leaf cells; **G**, Basal laminal cells (D–G, *A.C.Beauglehole 16281*, AD); **H**, Peristome: exostome tooth (left), cilium separate; endostome with basal membrane and endostome segment (right) (*H.P.Ramsay 76/84*, NSW). **I–O**, *Gemmabryum australe*. **I**, Habit of dry specimen; **J**, Capsule; **K**, Peristome: exostome tooth (left); endostome basal membrane with segment (centre); cilium (right); **L**, Cells at leaf apex; **M**, Leaf; **N**, Mid-leaf cells; **O**, Basal laminal cells (I–O, *H.P.Ramsay 3/88*, NSW). **P–V**, *G. cheelii*. **P**, Habit with sporophyte (dry specimens); **Q**, Capsule without operculum; **R**, Leaf (isotype, NSW); **S**, Cells at leaf apex; **T**, Mid-leaf cells; **U**, Basal laminal cells (R–U, *D.G.Catcheside 73.203*, AD); **V**, Gemma (rhizoidal tuber) (isotype) Scale bars: 1 mm for habit; 0.5 mm for leaves, 100 µm for cellular drawings. Drawn by L.Elkan.

14. Gemmabryum inaequale (Taylor) J.R.Spence & H.P.Ramsay, *Phytologia* 87: 67 (2005)

Bryum inaequale Taylor, *London J. Bot*. 5: 53 (1846). T: Swan R., W.A., 1843, *J.Drummond s.n.*; holo: BM; iso: H.

Bryum calodictyon Broth., *Proc. Linn. Soc. New South Wales* 41: 589 (1916). T: Green Gully, near Young, N.S.W., *W.W.Watts 7244*; lecto: H-BR, *fide* J.R.Spence & H.P.Ramsay, *Fl. Australia* 51: 411 (2006); back of cemetery, Young, N.S.W., *W.W.Watts 7244*; syn: NSW.

Illustrations: H.Ochi, *J. Fac. Educ. Tottori Univ. Nat. Sci.* 21: 34, fig. 17 (type of *B. inaequale*); 37, fig. 19 (as *Bryum calodictyon*) (1970).

Dioicous. Plants small, to 10 mm tall, glossy green or yellow-green, brownish and radiculose below. Rhizoids brown or red-brown. Leaves imbricate, comose, appressed when dry, erect-spreading when moist, triangular-lanceolate, 1–2 mm long, concave; apex acuminate; margin slightly recurved, entire or serrulate above, not bordered; costa slender, reddish below, percurrent or short-excurrent; laminal cells sublinear, > 100 µm long, 10–12 µm wide (6–8: 1), thin-walled; alar region clearly differentiated; cells quadrate, > 20. Gemmae absent. Setae to 14 mm long, slender, red-brown. Capsules horizontal to nutant, 2–3 mm long, widest at middle, long-necked, tapering to seta; operculum low-conical. Exostome teeth yellow-brown; endostome of slender narrowly fenestrate segments; cilia 2 or 3, mostly well developed, occasionally blunt or reduced, nodulose or short-appendiculate. Spores 11–15 µm diam. Chromosome number not known. Fig. 39P–U.

Endemic to W.A., S.A., Qld, N.S.W. and Vic.; grows on soil, often on vertical banks. Map 173.

W.A.: Fitzgerald R. crossing, Fitzgerald River Natl Parl, *J.R.Spence 4168* (NSW). S.A.: Millicent, L. Leake, *L.D.Williams 3537* (AD). Qld: Granite Gorge, Mareeba, *I.G.Stone 21971* (MEL). N.S.W.: Wombat, near Young, *W.W.Watts 7857*, *7864*, *7856*, *7800*, *7843* (NSW). Vic.: Mt William, *D.Sullivan s.n.* (MEL).

Characterised by the glossy, yellowish green leaves and elongate, thin-walled laminal cells, *G. inaequale* has a habit reminiscent of a small, creeping pleurocarpous moss. It is closely related to *G. acuminatum*, from which it differs by the narrow capsule mouth and the well-developed peristome. These two species, as well as *G. apiculatum*, form part of a complex of poorly defined species that requires worldwide revision.

15. Gemmabryum indicum (Dozy & Molk.) J.R.Spence & H.P.Ramsay, *Phytologia* 87: 67 (2005)

Bryum indicum Dozy & Molk., *Musci Frond. Ined. Archip. Ind.* 1: 22 (1845); *Brachymenium indicum* (Dozy & Molk.) Bosch & Sande Lac., *Bryol. Javan.* 1: 141 (1860). T: West Java, [Indonesia], *F.Korthals*; *n.v.*

Illustrations: H.C.Gangulee, *Mosses of Eastern India and Adjacent Regions* 2: 943, fig. 452 (1974); A.Eddy, *Handb. Malesian Mosses* 3: 173, fig. 448 (1996), both as *Brachymenium indicum*.

Synoicous. Plants small, to 10 mm tall, densely tufted, dark green or yellowish, slightly glossy. Stems erect, red, branched by several subperichaetial innovations, matted with reddish tomentum. Rhizoids red to red-brown. Leaves closely set, small; upper leaves larger and forming a comal tuft, ovate or broadly lanceolate, c. 1 mm long, erect-spreading when moist, contorted and appressed to the stem when dry; apex acuminate; margin narrowly revolute below; costa excurrent in a short- or long-denticulate arista, brown or yellowish, occasionally hyaline; upper laminal cells elongate-rhomboidal, thin- or slightly thick-walled, 30–50 × 10–15 µm (3–4: 1); basal cells quadrate to short-rectangular; marginal cells longer and a little narrower, forming an indistinct border. Gemmae as bulbils with leafy primordia; rhizoidal tubers occasionally present, small (100–200 µm), reddish brown, globose. Perichaetial leaves larger than vegetative leaves, with a less excurrent costa and a revolute margin. Setae reddish, 10–19 mm long. Capsules fusiform, erect or very slightly inclined, 2–3 mm long, brown; apophysis somewhat rugose, tapered below; operculum umbonate. Peristome reduced; exostome teeth 16, yellow; endostome delicate, variable; segments the same length as exostome teeth but fragile; cilia apparently lacking. Spores 9–12 µm diam. Chromosome number not known.

Occurs in subtropical and tropical W.A., N.T. and Qld; grows on soil, occasionally over rock. Also in India and Malesia. Map 174.

W.A.: Cockburn Ra., SW of Wyndham, *H.Streimann 39466* (CANB). N.T.: Kakadu Natl Park, *I.G.Stone 23427* (MEL). Qld: Mungana, *I.G.Stone 16739* (MEL); 20 km E of Chillagoe, *J.R.Spence 5116* (NSW).

Although *G. indicum* was reported by Dixon (1942: 31) for Australia, it was not listed by Ochi (1970, 1982). It is now known to be more widespread than previously thought.

Although closely related to *G. coarctatum*, *G. indicum* can be distinguished by its green, unbordered leaves lacking hyaline upper parts, quadrate basal cells (at least in the alar region), the absence of stem tubers, and synoicous sexuality. Australian collections have bulbils with small laminate leaf primordia and rhizoidal tubers, characters not reported previously for the species.

16. Gemmabryum klinggraeffii (Schimp.) J.R.Spence & H.P.Ramsay, *Phytologia* 87: 67 (2005)

Bryum klinggraeffii Schimp., *in* H.E.M. von Klinggraeff, *Höh Crypt. Preuss.* 81 (1858). T: Europe; *n.v.*

Illustrations A.J.E.Smith, *Moss Flora of Britain and Ireland* 424, fig. 202 (6–10) (1978); D.G.Catcheside, *Mosses of South Australia* 276, fig. 164b (tubers) (1980), both as *Bryum klinggraeffii*.

Dioicous. Plants small, 2–5 mm tall, variously coloured, not distinctly glossy. Rhizoids almost smooth, pale yellowish to red-brown. Leaves small to medium-sized, 1.0–1.5 mm long, somewhat contorted, loosely imbricate, ovate-lanceolate to lanceolate with an acute apex; margin plane or revolute to mid-leaf, finely serrulate near apex; costa short-excurrent; laminal cells mostly 45–60 × 10–15 µm (4–6: 1), thin-walled to somewhat incrassate; cells in lower quarter short-rectangular across base; cells longer and narrower at margin but not forming a border. Gemmae rhizoidal tubers, abundant, never axillary, bright crimson, small, 60–100 µm, irregularly globose, mostly 3 or more cells wide; superficial cells protuberant; stem tubers rare, pale whitish tan. Perichaetial leaves triangular, with strongly revolute margins. Setae thick, to 10 mm long, red-brown. Capsules broadly pyriform, 1–2 mm long, strongly contracted below mouth when dry and empty. Peristome well developed; exostome teeth yellow to brown, papillose; endostome with a high basal membrane; segments broadly perforate; cilia 2 or 3, well developed, appendiculate. Spores 8–12 µm diam. Chromosome number not known.

Occurs in W.A. and N.T.; grows on soil, often in disturbed areas. Also in Eurasia, North and South America, Lord Howe Is. and New Zealand. Map 175.

W.A.: Osmund Valley, SE Kimberley, *coll. unknown* (AD). N.T.: Mt Palmer, NW of Alice Springs, 26 Aug. 1956, *J.B.Cleland* (AD).

This species can be confused with *G. sauteri* which has smaller, brown, pyriform tubers that are concolorous with the rhizoids. Remarkably, a collection from arid, central W.A. has small but well-developed stem tubers as in *G. coarctatum* and *G. eremaeum*.

17. Gemmabryum laevigatum (Hook.f. & Wilson) J.R.Spence & H.P.Ramsay, *Phytologia* 87: 67 (2005)

Bryum laevigatum Hook.f. & Wilson, *London J. Bot.* 3: 546 (1844). T: Tas., locality unknown, *J.D.Hooker 2856*; holo: BM.

Bryum crassinerve Hook.f. & Wilson, *in* J.D.Hooker, *Fl. Nov.-Zel.* 2: 83 (‘1855’) [1854]. T: Munyang Mtns, Vic., 1855, *F.Mueller*; syn: BM; Alps, Tas., *Stirling*; syn: MEL.

Bryum incurvifolium Müll.Hal., *Bot. Zeitung (Berlin)* 9: 549 (1851). T: Qld, *Mossman s.n.*; iso: H.

Illustrations: J.Beever, K.W.Allison & J.Child, *Mosses of New Zealand*, 2nd edn 67, pl. 61 (1992); R.D.Seppelt, *The Moss Flora of Macquarie Island* 105, fig. 40 (2004), both as *Bryum laevigatum*.

Dioicous. Plants robust, 1–4 (–10) cm tall, in loose tufts or strands, simple or branched, green above, yellow-green, brown-green or blackish below, dull or glossy. Stems matted and radiculose below. Rhizoids purplish brown, strongly papillose. Leaves ±glossy, flat or weakly concave, oblong, ovate-oblong or elliptic, 2–3 mm long, only slightly crisped

(incurved) when dry, erect and appressed; apex obtuse; margin recurved, serrulate towards the apex; costa strong, dark, percurrent on most leaves, strongly keeled along the abaxial side of the leaf when dry; upper laminal cells small and wide, mostly 25–50 × 12–25 µm (1.5–3: 1), elongated diagonally or obliquely to costa, strongly incrassate, porose; lower basal cells rectangular, with some quadrate cells present; lower margin sometimes with a strong border of narrow cells; leaf base green. Gemmae absent. Setae 20–40 mm long. Capsules clavate, erect to horizontal or pendulous, 2.5–3.5 mm long, brown. Exostome teeth lanceolate, with hyaline margins and a straight to zig-zag median line; endostome segments widely split, appendiculate; basal membrane more than half the length of the segments; cilia 2 or 3. Spores 16–20 µm diam. Chromosome number not known. Fig. 40P–W.

Occurs in W.A., Qld, N.S.W., A.C.T., Vic. and Tas.; grows on soil or rock, mainly in boggy or marshy ground or creeks. Also known from southern South America, Macquarie Is. and New Zealand and its Subantarctic islands. Map 176.

N.S.W.: Yarrangobilly Caves, *W.W.Watts 8712* (NSW); Diggers Ck, 28 km NE of Mt Kosciuszko, *H.Streimann 5449* (AD). Vic.: Bogong High Plains, *C.Skewes s.n.* (MEL). Tas.: L. Dobson, *H.P.Ramsay R1635* (NSW).

Gemmabryum laevigatum is a distinctive species that superficially looks like some forms of *Ptychostomum pseudotriquetrum* from which it differs by the broad, non-decurrent, fleshy and ±rounded leaves, oblique areolation, and a lack of dense tomentum on the stem. This species grows in similar habitats to *Ochiobryum blandum*, but *G. laevigatum* has smaller, denser areolation, concave fleshy leaves that are never red-pink or silver-tinged, and stems that are not complanate.

18. Gemmabryum pachythecum (Müll.Hal.) J.R.Spence & H.P.Ramsay, *Phytologia* 87: 64 (2005)

Bryum pachytheca Müll.Hal., *Syn. Musc. Frond.* 1: 307 (1848). T: York, W.A., 10 Sept. 1839, *L.Preiss 2466*; lecto: BM, *fide* J.R.Spence & H.P.Ramsay, *Fl. Australia* 51: 411 (2006); isolecto: MEL 30783; India Orientalis, Herb. Gottscheanum; syn: L.

Bryum suboeneum Hampe & Müll.Hal., *Linnaea* 26: 494 (1853). T: Yarra R., Vic., *F.Mueller*; holo: MEL; iso: BM.

Bryum pachytheca Müll.Hal. var. *inflatum* Wilson, *in* J.D.Hooker, *Fl. Tasman*. 2: 191 (1859). T: Tas., *A.F.Oldfield*; holo: *n.v.*

Bryum gambierense Müll.Hal., *Linnaea* 37: 148 (1871). T: Mt Gambir [Gambier], S.A., *F.Mueller*; iso: BM.

Bryum cupulatum Müll.Hal., *Linnaea* 37: 149 (1871). T: Brown Hill Creek, Vic., *F.Mueller*; holo: *n.v.*

Bryum pachythecioides Müll.Hal., *Fragm.* 11 (Suppl.): 48 (1881), *nom. nud.* [Name used for eastern Australian populations of *B. pachytheca*.]

Bryum ovicarpum Broth., *Oefvers Förh. Finska Vetensk.-Soc.* 42: 101 (1900). T: Hobert [Hobart], Tas., *W.A.Weymouth 1834*; holo: H-BR.

Bryum pachytheca Müll.Hal. var. *crassinerve* Wilson ex Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 137 (1906). T: Tas., *R.C.Gunn*; holo: *n.v.*

Bryum campbelliae Müll.Hal. ex Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 142 (1906), *nom. nud.* (in synon.). Based on: Vic., locality unknown, *F.M.Campbell* (BRI, MEL, NSW).

Bryum capillaripes Müll.Hal. ex Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 143 (1906), *nom. nud*. (in synon.). Based on: Sandy Desert, Dimboolshire [Dimboola Shire], Vic., Aug, 1886, *F.M.Reader* (MEL).

Bryum piligerum Müll.Hal. ex Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 143 (1906), *nom. nud*. (in synon.). Based on: Mt Arapiles, Vic., Aug. 1896, *F.M.Reader* (MEL).

Bryum pruinosum Müll.Hal. ex Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 143 (1906), *nom. nud*. (in synon.). Based on: Dimboolshire [Dimboola Shire], Vic., May 1897, *F.M.Reader* (MEL).

Bryum gambierense Müll.Hal. var. *nanum* Müll.Hal. ex Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 143 (1906), *nom. nud.* (in synon.).

Illustrations: H.Ochi, *J. Fac. Educ. Tottori Univ. Nat. Sci.* 21: 22, fig. 8A–H (1970), as *Bryum bicolor*; G.A.M.Scott & I.G.Stone, *The Mosses of Southern Australia* 286, pl. 52, (1976), as *Bryum pachytheca*; D.G.Catcheside, *Mosses of South Australia* 266, fig. 155 (1980), as *Bryum pachytheca*.

Dioicous. Plants in mats or tufts, golden-green to reddish green. Stems erect, 5–10 mm tall. Rhizoids brown to red-brown, common. Leaves elliptical to lanceolate, 0.6–1.5 mm long, weakly concave, tapering to an acute apex, erect to patent, not much altered when dry; margin plane, entire; costa strong, excurrent in a short coloured arista, denticulate at tip, yellow or red; upper and mid-laminal cells rhomboidal to obliquely rectangular, 20–45 × 9–15 µm (3–4: 1), smooth, with thin or thick walls; basal cells narrower, rectangular to quadrate. Gemmae as bulbils, axillary, oblong to obovate to ellipsoidal on sterile stems, often more than 1 per axil, without primordia or leaves or with minute peg-like rudiments of primordia at apex; stem tubers absent. Perichaetial leaves similar to vegetative leaves. Setae 5–10 mm long, red. Capsules pendent, broadly ovate, c. 2 mm long, purplish to crimson-brown; apophysis wider than the urn when moist, narrower when dry, rugose to corrugate, abruptly expanded from the seta, somewhat inflated, much darker than the urn; operculum low-conical. Peristome well developed; exostome teeth lanceolate, yellow, minutely papillose, with hyaline apices; endostome with a high basal membrane, two-thirds the height of the exostome teeth; segments tapering, with broad perforations; cilia 2, appendiculate. Spores 8–13 µm diam., finely papillose. *n* = 10, *fide* H.P.Ramsay & J.Spence, *J. Hattori Bot. Lab.* 80: 259 (1996), as *Bryum pachytheca*. Fig. 41J–P, Frontispiece.

A common species on damp or dry soil or rock in all States and Territories. Also in SE Asia, Melanesia, New Zealand and western Oceania. Map 177.

W.A.: Hyden, *L.D.Williams 3920b* (AD). N.T.: Mt Riddock, Harts Ra., *A.C.Beauglehole 44657* (MEL). S.A.: Flinders Ra., *L.D.Williams 5659* (AD). N.S.W.: Warrumbungles Ra., *I.G.Stone 4080* (MEL). A.C.T.: Acton, Canberra, *D.G.Catcheside 68.132* (MEL). Vic.: Moyston, *D.Sullivan 19* (MEL).

In Australasia, *G. pachythecum* is a common species of sandy and loamy soils, and sometimes rock, and in urban habitats including gutters and crevices in walls. The species is very variable, but the capsules are distinctive. Bulbils differ from those of *G. dichotomum* in the absence of leafy primordia. It is distinguished from *G. eremaeum* by the red or brownish rather than hyaline arista and the absence of primordia on the bulbils.

19. Gemmabryum preissianum (Hampe) J.R.Spence & H.P.Ramsay, *Phytologia* 87: 67 (2005)

Bryum preissianum Hampe, *Icon. Musc.* 25 (1844); *Brachymenium preissianum* (Hampe) A.Jaeger, *Ber. Tätigk. St. Gallischen Naturwiss. Ges.* 1873–74: 113 (1875). T: Freemantle [Fremantle], W.A., 14 Aug. 1823, *L.Preiss 2453*; lecto: BM, *fide* H.Ochi, *J. Fac. Educ. Tottori Univ. Nat. Sci.* 21(1): 13 (1970); isolecto: MEL; syn: BM (*Preiss 2451*); isosyn: MEL.

Brachymenium pilosithecium Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 121 (1906), *nom. nud.* (in synon.). Based on: Balls Head Bay (Mossmans Bay), N.S.W., Sept. 1884, *T.Whitelegge 146* (NSW).

Brachymenium chloroblastum Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 121 (1906), *nom. nud.* (in synon.). Based on: Moore Park, Sydney, N.S.W., Aug. 1891, *T.Whitelegge 368* (NSW).

Pohlia cuspidata E.B.Bartram, *Trans. Brit. Bryol. Soc.* 1: 468 (1951). T: Crawley, W.A., 10 Aug. 1945, *A.D.Banwell*; holo: MEL; iso: PERTH

Illustrations: H.Ochi, *J. Fac. Educ. Tottori Univ. Nat. Sci.* 21: 13, fig. 4 (1970); D.G.Catcheside, *Mosses of South Australia* 248, fig. 143 (1980); H.Streimann, *The Mosses of Norfolk Island* 18, fig. 5 (2002), all as *Brachymenium preissianum*.

Dioicous. Plants small, 3–8 mm tall, in dense green or yellow tufts. Stems short, branched by perichaetial innovations. Leaves imbricate, lanceolate or ovate-lanceolate, to 1 mm long, erect whether dry or moist; apex acuminate; margin plane, entire; costa strong and broad, excurrent in a stout cuspidate point, yellowish brown; upper laminal cells rhomboidal-hexagonal, 25–35 × 10–12 µm, pellucid, with firm or thick walls; 1 or 2 marginal rows narrower, short-rectangular, not forming a distinct border; basal cells rectangular. Gemmae absent. Setae 5–15 mm long, slender, flexuose, yellow above, reddish below. Capsules inclined or horizontal, oblong-elliptical, 2.0–2.5 mm long, dark reddish brown; apophysis distinct; mouth narrow; operculum conical, short-rostellate. Peristome reduced; exostome teeth 16, narrowly lanceolate, subulate, to 400 µm long, yellow and finely papillose to smooth below, hyaline and papillose above; inner surface lamellate; endostome segments 16, narrowly linear, to 150 µm long, papillose, slightly rimose; basal membrane papillose, one-third

the height of the exostome teeth; cilia absent. Spores 8–10 µm diam. *n* = 10, 22, 30, *fide* H.P.Ramsay & J.R.Spence, *J. Hattori Bot. Lab*. 80: 263 (1996), as *Bryum preissianum*.

Occurs in all States and Territories; grows on rock (especially limestone) and on soil over rock. Also in New Zealand. Map 178.

W.A.: Busselton, Sept. 1917, *E.B.Bartram* (MEL). N.T.: Finke R., *H.Kempe 1882* (MEL). S.A.: Meningie, *L.D.Williams 112* (AD). Vic.: Moleside Ck, *A.C.Beauglehole 1356* (MEL).

This species is characterised by lanceolate or ovate-lanceolate leaves with a short, stout hairpoint, inclined to horizontal capsules with a narrow mouth, and a rostellate operculum.

Although this species is dioicous, capsules are frequently produced.

20. Gemmabryum radiculosum (Brid.) J.R.Spence & H.P.Ramsay, *Phytologia* 87: 67 (2005)

Bryum radiculosum Brid., *Muscol. Recent.*, Suppl. 3: 18 (1817). T: Rome, Italy; holo: B? *n.v.*

Illustrations: A.J.E.Smith, *Moss Flora of Britain and Ireland* 424, fig. 202 (1–5) (1978); H.Streimann, *The Mosses of Norfolk Island* 32, fig. 11 (2002), both as *Bryum radiculosum*.

Dioicous. Plants densely tufted, 3–10 mm tall, pale green to reddish green. Rhizoids yellowish brown, coarsely papillose. Leaves ovate-lanceolate, 1–2 mm long, sharply acuminate, somewhat shrunken when dry; upper margin serrulate, unbordered, revolute below; costa strong, long-excurrent, yellow or sometimes reddish when old; mid-laminal cells 40–60 × 10–12 µm (3–5: 1), slightly longer and narrower at the margin; basal laminal cells quadrate. Gemmae usually present, sometimes sparse, as rhizoidal tubers 100–200 µm, brown or red, globose; cells not protuberant. Perichaetial leaves triangular, with strongly revolute margins. Setae 10–20 mm long, reddish. Capsules ovate-cylindrical to ellipsoidal, narrowing to the mouth, 2–3 mm long; operculum low-conical. Peristome well developed; exostome teeth yellow to brown, papillose; endostome with a high basal membrane; segments broadly perforate; cilia 2 or 3, well developed, appendiculate. Spores 10–14 µm diam. Chromosome number not known.

Occurs in W.A., N.T., S.A., Qld and Vic.; grows as dense tufts on old mortar and limestone and on dry calcareous soil; often on soil in arid regions. Also in central, southern and western Europe, Macaronesia, the Caribbean, Lord Howe Is. and New Zealand. Map 179.

W.A.: Samin mining camp, E Osmund Valley, E Kimberley, *E.A.Chesterfield 236* (MEL); Beverley Springs Stn, Kimberley, 1 May 1988, *G.A.M.Scott* (MEL). N.T.: Mt Giles, *P.K.Latz 6614 p.p.* (AD). Vic.: Trentham Falls, 16 km E of Daylesford, *H.Streimann 38988* (CANB).

Gemmabryum radiculosum can be confused with *G. subapiculatum* from which it differs in the narrow, somewhat incrassate upper and middle laminal cells, the quadrate basal cells, the long-excurrent costa and its preference for calcareous substrata.

21. Gemmabryum rubens (Mitt.) J.R.Spence & H.P.Ramsay, *Phytologia* 87: 68 (2005)

Bryum rubens Mitt., *Hooker's J. Bot. Kew Gard. Misc.* 8: 232 (1856). T: Europe; *n.v.*

Illustrations: A.J.E.Smith, *Moss Flora of Britain and Ireland* 429, fig. 206 (1978); D.G.Catcheside, *Mosses of South Australia* 276, fig. 164e (1980); A.Eddy, *Handb. Malesian Mosses* 3: 136, fig. 421 (1996), all as *Bryum rubens*.

Dioicous. Plants small, 10–20 mm tall, tufted and closely gregarious, rarely tufaceous, dull-green, olive or with reddish tints. Rhizoids deep reddish brown, papillose. Leaves erect-spreading, not closely imbricate, ovate-lanceolate to lanceolate, c. 2 mm long; apex acuminate; margin plane or revolute to mid-leaf, distinctly and remotely denticulate above; costa slender, short-excurrent; mid-laminal cells 40–60 × 16–20 µm, thin-walled, the 2 or 3 marginal rows longer, narrower with more incrassate and deeply pigmented walls, forming a distinct border. Gemmae often abundant, solitary as bulbils in leaf axils or as rhizoidal tubers on short rhizoids and clustered around stem base, crimson to red, conspicuous, globose, 150–300 µm diam.; cells distinctly protuberant across face. Perichaetial leaves triangular, with strongly revolute margins. Setae c. 20 mm long, red-brown to brown. Capsules clavate

to pyriform, 2–3 mm long, not distinctly curved when dry; operculum low-conical. Peristome well developed; exostome teeth yellow to brown, papillose; endostome with a high basal membrane; segments broadly perforate; cilia 2 or 3, well developed, appendiculate. Spores 8–12 µm diam. Chromosome number not known.

Known from disturbed soil in Qld, N.S.W. and Vic. Also in Europe, North America, India, Japan, Malesia and New Zealand. Map 180.

Qld: Mt Baldy, *I.G.Stone s.n*. (MEL). N.S.W.: Royal Botanic Gardens, Sydney, *R.G.Coveny 13189* (NSW); Jenolan Caves, *H.P.Ramsay R34a* (NSW). Vic.: White Bridge, Mt Buller, *I.G.Stone 2496* (MEL).

This moss is characterised by the abundant, crimson, globose tubers 150–300 µm diam., the often reddish colour of the leaves, and the presence of a leaf border and broad laminal cells. It is often found on disturbed soils, and it may have been introduced.

22. **Gemmabryum sauteri** (Bruch & Schimp.) J.R.Spence & H.P.Ramsay, *Phytologia* 87: 68 (2005)

Bryum sauteri Bruch & Schimp., *in* Bruch, Schimper & von Gumbel, *Bryol. Eur*. 4: 162 (1846). T: Europe; *n.v.*

Illustrations: A.J.E.Smith, *Moss Flora of Britain and Ireland* 426, fig. 203 (5–7) (1978); H.Streimann, *The Mosses of Norfolk Island* 34, fig. 12 (2002); R.D.Seppelt, *The Moss Flora of Macquarie Island* 111, fig. 43 (2004), all as *Bryum sauteri*.

Dioicous or synoicous. Plants small, to 5 mm tall, dull green. Rhizoids red-brown, finely papillose. Leaves ovate-lanceolate, c. 1.4 mm long and 0.4 mm wide, somewhat shrunken when dry, acuminate; margin ±entire above, recurved at base; costa strong, excurrent in a long hairpoint; laminal cells 40–70 × 10–14 µm (4–5: 1), incrassate, slightly narrower towards margin, not forming a border; cells in lower quarter short-rectangular across leaf base to costa. Gemmae as rhizoidal tubers, usually abundant, never axillary, brown to red-brown, pyriform, 60–100 × 40–60 µm, mostly with 2 or 3 cells across the face; cells not or slightly protuberant. Perichaetial leaves triangular, with strongly revolute margins. Setae 10–20 mm long, brown. Capsules narrowly pyriform, inclined to nutant, 2–3 mm long, distinctly contracted just below the mouth; operculum low-conical. Peristome well developed; exostome teeth yellow to brown, papillose; endostome with a high basal membrane; segments broadly perforate; cilia 2 or 3, well developed, appendiculate. Spores large, 16–20 µm diam. $n = 10 + m$, *fide* H.P.Ramsay & J.R.Spence, *J. Hattori Bot. Lab*. 80: 255 (1996), as *Bryum sauteri*.

Occurs on roadsides and stream banks on soil or on soil over rock in W.A., Qld, N.S.W., Vic. and Tas. Also in Europe, North America, SE Asia, New Guinea, New Zealand, Lord Howe Is., Norfolk Is. and Macquarie Is. Map 181.

Qld: below Aljon Falls, Carnarvon Gorge Natl Park, *J.R.Spence 5167* (NSW). N.S.W.: Wilsons Ck, Richmond R., *W.W.Watts 1633* (NSW). Vic.: Avon R., *F.Mueller* (MEL). Tas.: Hogan Is., Bass Strait, *G.K.Thomson* (MEL 29830).

A widespread and variable species, *G. sauteri* is most similar to *G. klinggraeffii* from which it differs by the small pyriform tubers, larger spores and often synoicous sexuality.

23. **Gemmabryum subapiculatum** (Hampe) J.R.Spence & H.P.Ramsay, *Phytologia* 87: 68 (2005)

Bryum subapiculatum Hampe, *Vidensk. Meddel. Dansk. Naturhist. Foren. Kjøbenhavn*, ser. 3, 4: 51 (1872). T: Europe; *n.v.*

Bryum microerythrocarpum Müll.Hal. & Kindb., *Cat. Canad. Pl*. 6: 124 (1892). T: Canada?; *n.v.*

Bryum tryonii Broth., *Oefvers Förh. Finska Vetensk.-Soc*. 35: 49 (1893). T: South Brisbane, Qld, Aug. 1870, *H.Tryon 806*; holo: H-BR; iso: MEL, NSW.

Bryum caespiticioides Müll.Hal., *Hedwigia* 37: 89 (1898). T: Queens River Rd, Macquarie Harbour, West Coast, Tas., *W.A.Weymouth 565*; isosyn: H; Hobart Waterworks, Tas., *W.A.Weymouth s.n.*; isosyn: NSW.

Illustrations: H.Ochi, *J. Fac. Educ. Tottori Univ. Nat. Sci*. 21: 28, fig. 12A–H (1970), as *Bryum. tryonii*; D.G.Catcheside, *Mosses of South Australia* 276, fig. 164f (1980), as *B. microerythrocarpum*; J.Beever, K.W.Allison & J.Child, *Mosses of New Zealand*, 2nd edn 93, fig. 40h (1992), as *B. microerythrocarpum*.

Plate 33. *Conostomum pentastichum*.
Photograph — W.M.Malcolm.

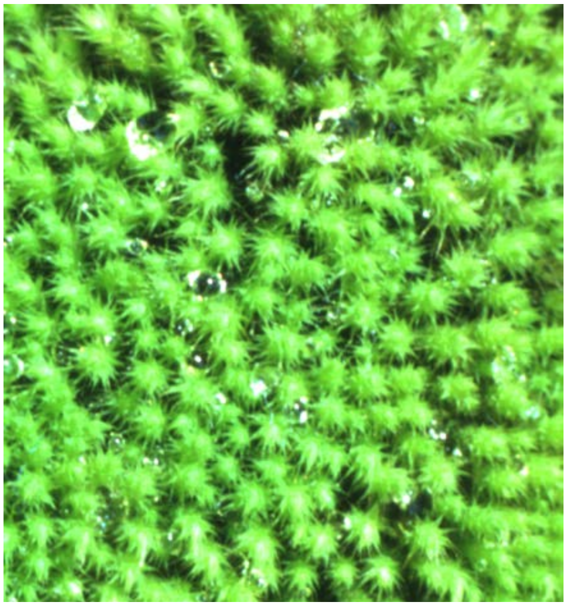

Plate 34. *Philonotis tenuis*.
Photograph — H.Lepp.

Plate 35. *Philonotis scabrifolia*.
Photograph — W.M.Malcolm.

Plate 36. *Gemmabryum exile*.
Photograph — H.Lepp.

Plate 37. *Bryum argenteum*.
Photograph — H.Lepp.

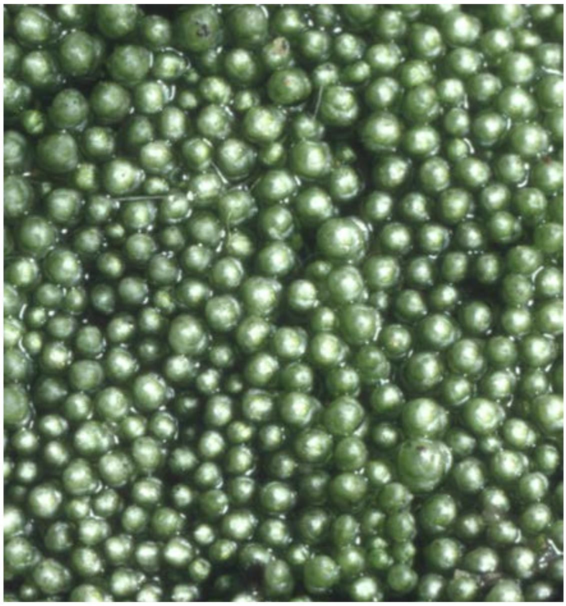

Plate 38. *Bryum argenteum*.
Photograph — H.Lepp.

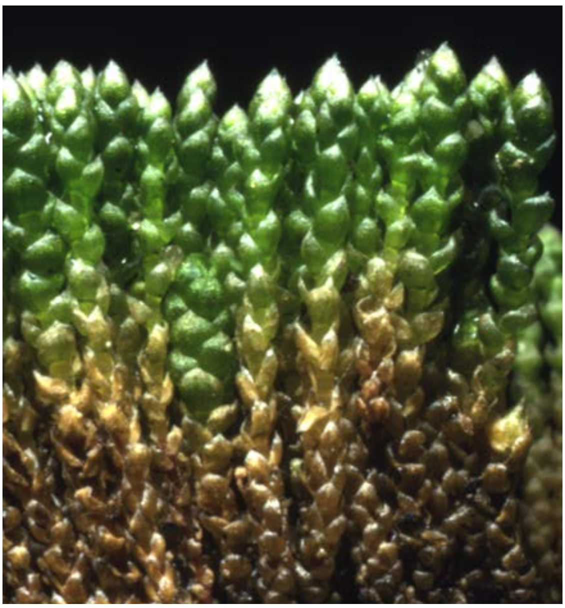

Plate 39. *Bryum argenteum*.
Photograph — H.Lepp.

Plate 40. *Gemmabryum dichotomum*.
Photograph — H.Lepp.

Plate 41. *Rosulabryum campylothecium*.
Photograph — H.Lepp.

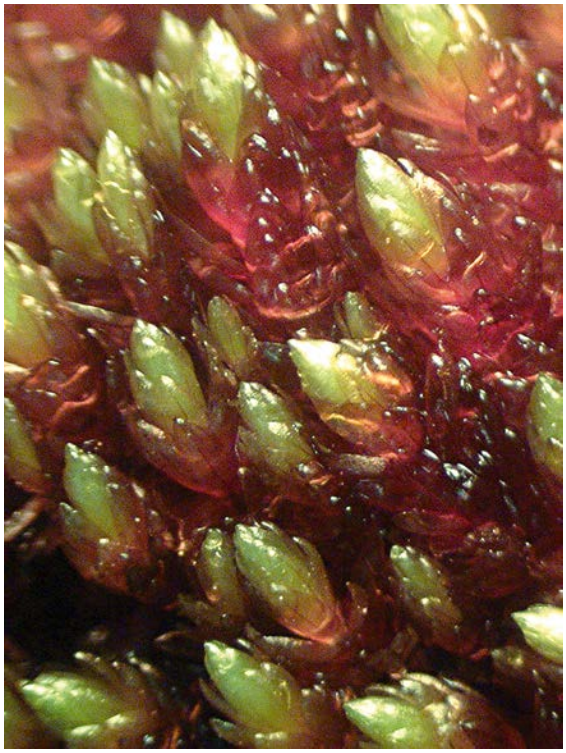

Plate 42. *Ochiobryum blandum*.
Photograph — W.M.Malcolm.

Plate 43. *Rosulabryum torquescens*.
Photograph — R.Oldfield.

Plate 44. *Rosulabryum billarderi*.
Photograph — H.Lepp.

Plate 45. *Leptostomum erectum*.
Photograph — R.Oldfield.

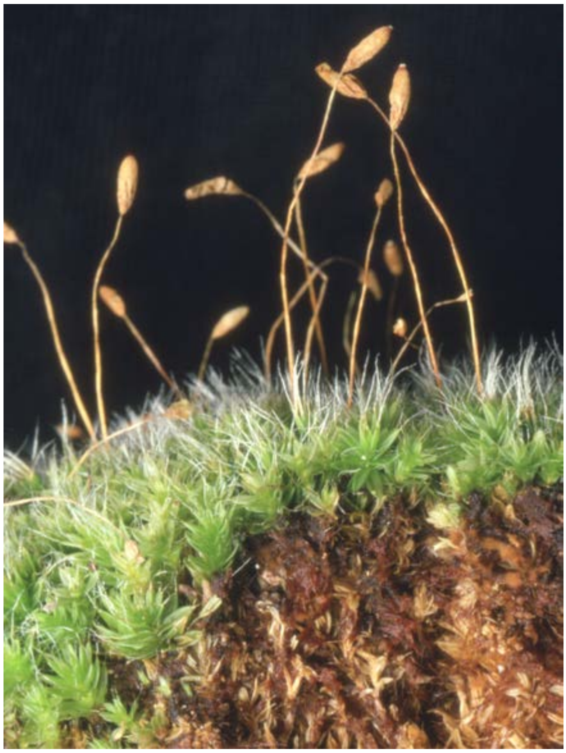

Plate 46. *Leptostomum macrocarpon*.
Photograph — H.Lepp.

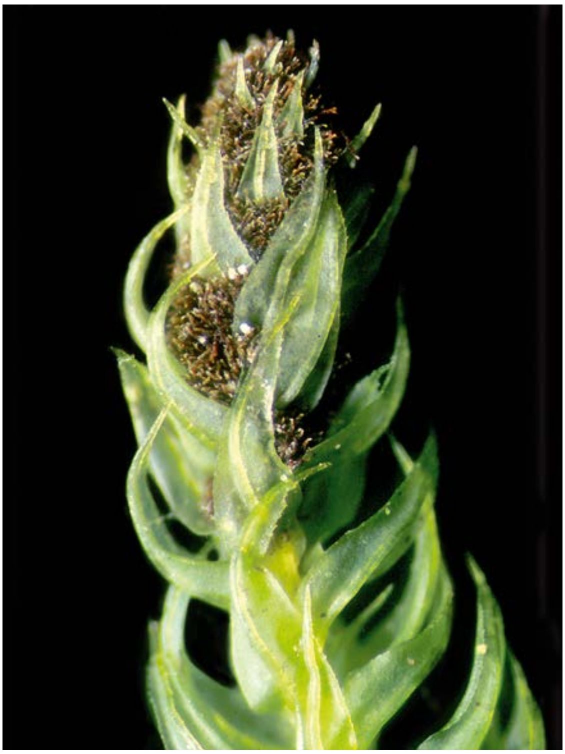

Plate 47. *Hymenodon pilifer*.
Photograph — W.M.Malcolm.

Plate 48. *Leptotheca gaudichaudii* var. *gaudichaudii*.
Photograph — W.M.Malcolm.

Plate 49. *Mesochaete undulata*.
Photograph — R.Oldfield.

Plate 50. *Pyrrhobryum mnioides*.
Photograph — W.M.Malcolm.

Plate 51. *Pyrrhobryum mnioides*.
Photograph — W.M.Malcolm.

Plate 52. *Pyrrhobryum paramattense*.
Photograph — H.Lepp.

Plate 53. *Rhizogonium distichum*.
Photograph — W.M.Malcolm.

Plate 54. *Calomnion complanatum*.
Photograph — W.M.Malcolm.

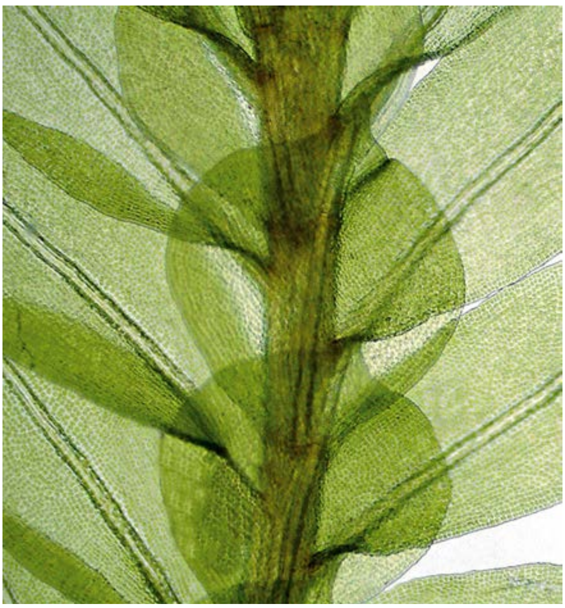

Plate 55. *Calomnion complanatum*.
Photograph — W.M.Malcolm.

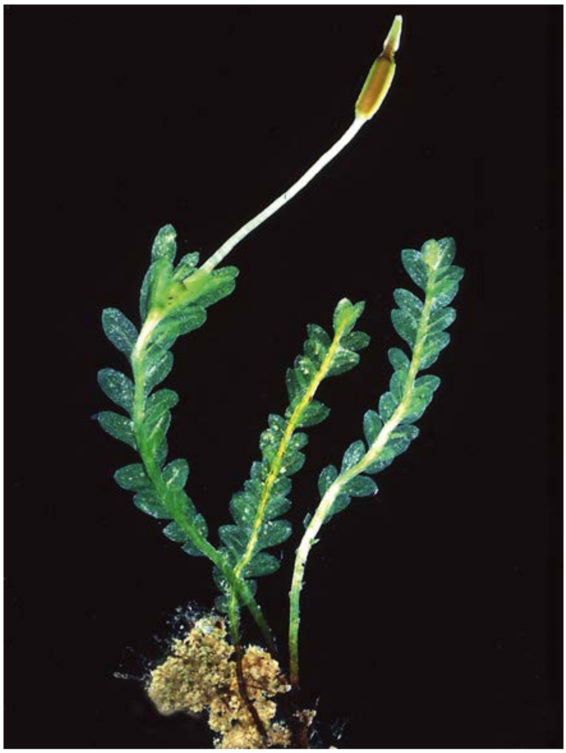

Plate 56. *Mittenia plumula*.
Photograph — R.Oldfield.

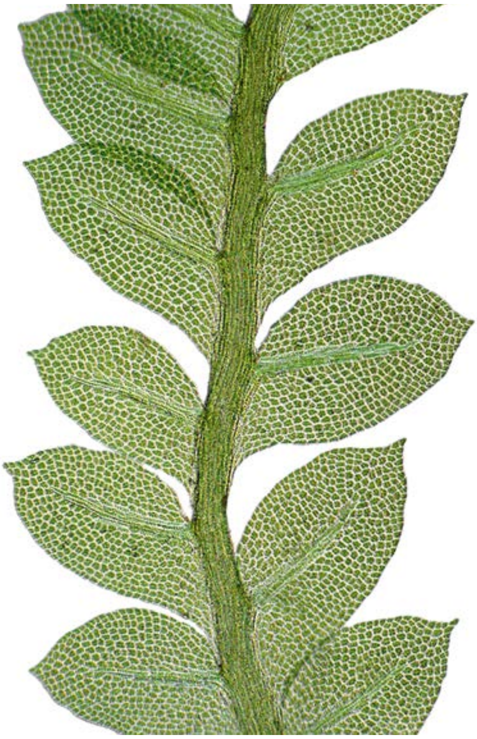

Plate 57. *Mittenia plumula*.
Photograph — W.M.Malcolm.

Plate 58. *Racopilum cuspidigerum* var. *convolutaceum*.
Photograph — H.Lepp.

Plate 59. *Cyathophorum bulbosum*.
Photograph — W.M.Malcolm.

Plate 60. *Cyathophorum bulbosum*.
Photograph — W.M.Malcolm.

Plate 61. *Hypopterygium tamarisci*.
Photograph — R.Oldfield.

Plate 62. *Hypopterygium tamarisci*.
Photograph — H.Lepp.

Plate 63. *Hypopterygium tamarisci*.
Photograph — R.Oldfield.

Plate 64. *Lopidium concinnum*.
Photograph — W.M.Malcolm

Dioicous. Plants small, green, in low tufts or colonies. Stems erect, to 4–8 mm tall, densely radiculose at the base. Rhizoids brownish, papillose. Leaves small, 0.6–1.4 mm long, broadly lanceolate, somewhat concave; apex acuminate; margin plane or slightly recurved below mid-leaf, remotely denticulate above; costa usually short-excurrent in a stiff projecting subula, brown; upper laminal cells with thin, firm or slightly thickened walls, 30–50 × 10 µm; marginal cells 1 or 2 rows, longer and narrower, forming an inconspicuous border; basal laminal cells short-rectangular, lax, with thin walls. Gemmae as tubers on long rhizoids, globose, bright orange-red, often 200–300 µm; walls not coloured; cells usually not protuberant. Perichaetial leaves lanceolate or triangular, with revolute margins. Setae 16–20 mm long, brown to red-brown. Capsules inclined-pendulous, ovate-cylindrical, 2–4 mm long, narrow at mouth; operculum low-conical. Peristome well developed; exostome teeth red, with hyaline edges and apices, minutely papillose; endostome segments yellow, as tall as exostome, densely papillose; basal membrane high; cilia 2 or 3, appendiculate. Spores small, 8–10 µm diam. Chromosome number not known. Fig. 42A–G.

Found on acidic soils, decomposing litter and on rotting or burnt wood in W.A., Qld, N.S.W., Vic. and Tas. Also in Eurasia, North America, New Guinea and New Zealand. Map 182.

W.A.: Porongorups, Oct. 1867, *F.Mueller* (MEL). Vic.: Mt Williams, Grampians Natl Park, *J.R.Spence 4399* (MEL).

This highly variable species is most likely to be confused with *G. rubens* which differs in having distinctly bordered leaves, broader laminal cells, and tubers with protuberant cells. *Gemmabryum radiculosum* is also similar, but differs in its longer leaf hairpoints, quadrate basal laminal cells, and in its ecology. The complex of species, including *G. subapiculatum*, *G. klinggraeffii*, *G. radiculosum*, *G. rubens*, *G. sauteri* and *G. tenuisetum*, is in need of a thorough revision.

24. Gemmabryum sullivanii (Müll.Hal.) J.R.Spence & H.P.Ramsay, *Phytologia* 87: 68 (2005)

Bryum sullivanii Müll.Hal., *in* V.F.Brotherus, *Oefvers. Förh. Finska Vetensk.-Soc.* 35: 48 (1893). T: Mt William, Vic., Nov. 1887, *D.Sullivan 22*; holo: H-BR? *n.v.*; iso: MEL.

Illustrations: D.G.Catcheside, *Mosses of South Australia* 273, fig. 161 (1980), as *Bryum* sp. A; J.R.Spence & H.P.Ramsay, *J. Adelaide Bot. Gard.* 17: 108–109, fig. 1 (1996), as *Bryum sullivanii*.

Dioicous. Plants tufted, green, yellow-green, brownish green or blackish, glossy when moist. Stems erect, densely and evenly foliate, 2–3 mm tall, tomentose below. Rhizoids reddish brown, finely papillose. Leaves ovate, concave, cymbiform, 1.5–2.0 mm long, ±imbricate when dry to somewhat twisted at the tips; margin erect, plane, smooth; costa thin, percurrent or ending below the obtuse apex; upper laminal cells often more than 60–100 × 20–30 µm, irregularly hexagonal, narrower and longer near the margin (border indistinct), gradually wider and rectangular at base. Gemmae as bulbils, often 1 or 2 in leaf axils. Perichaetial leaves ovate, acuminate. Setae 10–15 mm long, pale brown. Capsules pendulous, oblong, 2.0–2.5 mm long, abruptly contracted to the seta, symmetrical; mouth constricted, purple; apophysis thick, corrugate; operculum low-conical. Peristome well developed; exostome teeth yellow-brown, finely papillose; endostome segments pale, papillose; basal membrane c. half the height of the exostome; cilia 1–3, appendiculate, sometimes rather reduced. Spores 12–15 µm diam. Chromosome number not known. Fig. 41W–CC.

Endemic to W.A., S.A., N.S.W., A.C.T., Vic. and Tas. A rare species mainly on damp soil or rock in or near streams, often on limestone. Map 183.

W.A.: Beedelup Falls, Beedelup Natl Park, *J.R.Spence 4249*, *4255* (NSW). S.A.: Bellevue Heights, Adelaide, July 1988, *D.E.A.Catcheside* (AD). N.S.W.: Cascade, Wagga Wagga, *H.P.Ramsay R1509* (NSW). A.C.T.: Australian National University, Canberra, *D.G.Catcheside 68.136* (AD). Vic.: Grange Burn, near Hamilton, *D.G.Catcheside 77.202* (AD). Tas.: Killafaddy Hill, near Launceston, *W.A.Weymouth 2706* (NSW).

Gemmabryum sullivanii can be separated from related species by the longer and evenly foliate stems, and by the ovate, concave leaves with a weak costa.

25. Gemmabryum tenuisetum (Limpr.) J.R.Spence & H.P.Ramsay, *Phytologia* 87: 68 (2005)

Bryum tenuisetum Limpr., *Jahresber. Schles. Ges. Vaterl. Cult.* 74(2): 4 (1897). T: Europe; *n.v.*

Illustrations: A.J.E.Smith, *Moss Flora of Britain and Ireland* 427, fig. 204 (1–5) (1978); D.G.Catcheside, *Mosses of South Australia* 276, fig. 164d (1980), both as *Bryum tenuisetum.*

Dioicous or rarely synoicous. Plants erect, forming tufts, green to brown-green or rarely red-green. Stems 2–10 mm tall. Rhizoids pale, usually yellowish, papillose. Leaves small, narrowly lanceolate, 1–2 mm long; margin serrulate near apex, recurved below; costa usually short-excurrent, red-brown to dark red or purple with age; mid-laminal cells 50–80 × 12–14 µm (4–5: 1), incrassate; marginal cells somewhat longer, narrower and more incrassate but not forming a border; basal laminal cells short-rectangular. Gemmae common, as tubers on long rhizoids, mostly globose, golden-yellow with red walls, 100–200 µm diam.; cells distinctly protuberant. Perichaetial leaves triangular, with revolute margins. Setae 10–20 mm long, brown to red-brown. Capsules narrowly ellipsoidal, 1.5–2.0 mm long, red; operculum low-conical. Peristome well developed; exostome teeth yellow to brown, papillose; endostome with a high basal membrane; segments broadly perforate; cilia 2 or 3, appendiculate. Spores 12–16 µm diam. Chromosome number not known. Fig. 42O–W.

Occurs on soil in Qld and Vic. Also in Eurasia, North America, New Guinea and New Zealand. Map 184.

Qld: Broadwater Forest Park, 50 km W of Ingham, *I.G.Stone 24831 & M.Thorsborne* (MEL). Vic.: Rosanna, *I.G.Stone 1719* (MEL); Bogong High Plains, *I.G.Stone 9023* (MEL).

The yellow tubers with red walls are distinctive. This species is most similar to *G. subapiculatum*, but the latter has uniformly red tubers.

4. OCHIOBRYUM

Ochiobryum J.R.Spence & H.P.Ramsay, *Phytologia* 87: 68 (2005); named in honour of the late Harumi Ochi (1920–2002), Japanese bryologist and expert on the Bryaceae.

Type: *O. blandum* (Hook.f. & Wilson) J.R.Spence & H.P.Ramsay

Dioicous. Plants medium-sized, forming dense tufts 2–6 cm tall, red, pink, silver or sometimes green above, dark brown below. Stems simple or branched by short innovations, radiculose below. Rhizoids papillose, orange to crimson-brown. Leaves ovate, imbricate and appressed, concave, often complanate, suberect to erecto-patent, obtuse to broadly acute, little-altered when dry; margin entire; costa weak, not reaching the apex to short-excurrent in a slender point; laminal cells narrowly elongate (4–15: 1), often thicker-walled and narrower near margin, usually forming a distinct border, not much altered towards leaf base except at insertion where the cells are somewhat shorter. Gemmae lacking. Perigonia and perichaetia terminal; Australian plants sterile. Setae solitary, slender, flexuose, reddish. Capsules 3–4 mm long, suberect or inclined, pyriform, with a distinctly tapered neck; annulus absent; operculum conical, apiculate. Peristome double; exostome and endostome well developed; cilia appendiculate. Spores small, 10–18 µm diam., smooth.

Ochiobryum appears to be most closely related to *Pohlia*, *Leptobryum*, *Plagiobryum* and their allies. It is typified by *O. blandum* and also includes the Chinese species *O. handelii* (Broth.) J.R.Spence & H.P.Ramsay, the two forming a species pair that is phylogenetically distinct from *Bryum.* The genus is characterised by frequently complanate foliation, shiny pink to red colouration, elongate, pohlioid laminal areolation with a distinct border, and inclined to pendulous pyriform capsules with complete peristomes and small spores. Gemmae have not been seen by us or reported elsewhere. A third species, *Bryum pseudoblandum* T.Kop. & Norris, possibly belongs in *Ochiobryum*, but it appears to be somewhat distant from the other two as it is not or only weakly complanate, has much shorter and broader laminal cells and produces small, irregular, reddish rhizoidal tubers 150–250 µm diam. These three taxa form an interesting, vicariant, biogeographic pattern from north to south,

with *O. handelii* in SE Asia, *B. pseudoblandum* in New Guinea and *O. blandum* in Australasia. A fourth species, *Bryum lonchophyllum* Broth. from West Africa, which we have not seen, is said to be similar.

G.O.K.Sainsbury, *Bull. Roy. Soc. New Zealand* 5: 1–490 (1955); H.Ochi, On the status of *Bryum handelii* Broth. (Musci), *J. Jap. Bot*. 43: 480–485 (1968); T.Koponen & D.H.Norris, Bryophyte flora of the Huon Peninsula, Papua New Guinea. IV. *Anomobryum*, *Bryum*, and *Rhodobryum* (Bryaceae, Musci), *Ann. Bot. Fenn*. 21: 265–290 (1984); J.R.Spence & H.P.Ramsay, New genera and combinations in the Bryaceae (Bryales, Musci) for Australia, *Phytologia* 87: 61–71 (2005).

Ochiobryum blandum (Hook.f. & Wilson) J.R.Spence & H.P.Ramsay, *Phytologia* 87: 69 (2005)

Bryum blandum Hook.f. & Wilson, *London J. Bot*. 3: 546 (1844); *Fl. Antarct*. 1: 134 (1844). T: Campbell Is., New Zealand, *W.Wilson 22*; iso: BM.

Bryum blandum Hook.f. & Wilson var. *luridum* Wilson, *in* J.D.Hooker, *Fl. Nov.-Zel*. 2: 83 (‘1855’) [1854]. T: Makororo, North Is., New Zealand, *W.Colenso*; holo: BM.

Hypnum oblongifolium Hampe, *Linnaea* 30: 641 (1860). T: South Esk R., Vic., *F.Mueller*; holo: BM; iso: BM.

Bryum oblongifolium (Mitt.) Müll.Hal., *Genera Musc. Frond.* 234 (1901), *nom. illeg.* (later homonym).

Bryum virgatum Müll.Hal. ex Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 143 (1906), *nom. nud*. (in synon.). Based on: South Esk River, Vic., *F.Mueller s.n*. (MEL).

Illustrations: H.Ochi, *J. Jap. Bot.* 43: 193, fig. 1; 194, fig. 2 (1968), as *Bryum blandum*; W.R.Buck, D.H.Vitt & W.M.Malcolm, *Key to the Genera of Australian Mosses* 45 (2002), as “*Ochiobryum blandum*”; D.Meagher & B.Fuhrer, *Field Guide to the Mosses and Allied Plants of Southern Australia* 135 (2003), as *Bryum blandum.*

Plants forming dense tufts. Stems elongate, 1–6 cm tall, branched by short perichaetial innovations. Leaves glossy metallic pink or pinkish green, 1–3 mm long; upper leaves yellow-green or lurid green, moderately to clearly complanate, oblong, mostly obtuse, concave; costa not reaching apex or percurrent; laminal cells narrowly elongate (6–10: 1), at least 50–100 µm long, at the margin several rows of very narrow cells forming a distinct border; basal cells slightly shorter. Capsules not known from Australian collections. “Seta 2–4.5 cm long, slender, flexuose, reddish. Capsules 3–4 mm long, suberect or inclined, dark brown, pyriform with a distinct tapered neck. Operculum conical, apiculate. Peristome teeth separate but close together, lanceolate, yellow, hyaline above, finely papillose on the dorsal face, median line almost straight or zig-zag; ventral lamellae about 25; basal membrane of endostome less than half the height of the teeth; processes (=) narrow, subulate, cracked but not split, cilia appendiculate. Spores 16–24 µm” (Sainsbury, 1955). n = 11 (New Zealand), *fide* H.P.Ramsay & J.R.Spence, *J. Hattori Bot. Lab.* 80: 259 (1996). Fig. 43A–H, Plate 42.

A mainly subalpine to alpine species in W.A., N.S.W., A.C.T., Vic. and Tas.; grows on splashed or damp rock or soil often along streams. Also in New Zealand and Campbell Is. Map 185.

W.A.: Winnana Springs, Wable Downs Stn, E Kimberley, 13 May 1984, *J.H.Willis* (MEL). N.S.W.: Yarrangobilly, *W.W.Watts 8690* (NSW). A.C.T.: Punchbowl Ck, Booroomba area, *N.T.Burbidge 6817* (CANB). Vic.: Hopetown Falls, Otway Ra., *A.C.Beauglehole 16821* (MEL). Tas.: Liffey Falls, *J.R.Spence 4681* (NSW).

Ochiobryum blandum is a distinctive, hygrophilous species with shiny pinkish or reddish (rarely green), obtuse, bordered and usually concave leaves with a rounded apex and elongate laminal cells. It sometimes appears similar to *Gemmabryum laevigatum* which occurs in similar habitats, but it has finer areolation and stouter stems, and is typically complanate.

5. PLAGIOBRYUM

Plagiobryum Lindb., *Öfvers. Förh. Kongl. Svenska Vetensk.-Akad.* 20: 392 (1863); from the Greek *plagios* (oblique) and *bryon* (a moss), in reference to the oblique, decurved capsules.

Type: *P. zieri* (Hedw.) Lindb.

Dioicous. Plants small, densely tufted on soil, silvery green or vinous pink. Stems 20–40 mm tall, with julaceous innovations below the apex or lower down; stem bases clothed in a red tomentum of papillose rhizoids. Leaves closely imbricate, soft, concave, ovate- or oblong-lanceolate, reddish when old; margin entire; costa percurrent or failing below apex; laminal cells very lax and thin-walled, rhomboidal-hexagonal above, oblong-hexagonal below. Gemmae not known. Perichaetia and perigonia terminal; perichaetial leaves similar to vegetative leaves. Setae solitary, stout, almost cygneous. Capsules inclined to horizontal, large, pyriform, somewhat zygomorphic with a very long neck; urn gibbous; mouth oblique; annulus 2 rows of cells; operculum mammillose. Peristome double; exostome teeth 16; endostome segments 16, very narrow, almost as long as exostome teeth; basal membrane smooth; cilia rudimentary or absent. Spores large, densely papillose. n = 10, 11, *fide* R.Fritsch, *Bryophyt. Biblioth.* 40: 126, 219 (1991).

This genus of about ten species is highly distinctive and comparatively rare. It had been assumed that *Plagiobryum* was not present in Australia, although *Bryum wildii* (Broth.) Müll.Hal. was originally described as a *Plagiobryum* by Brotherus. The genus is characterised by lax laminal areolation and the unusual zygomorphic capsule that is asymmetrical and curved. These characters are also seen in Australian material of *B. cellulare*. Since that species is not related to other groups in *Bryum*, it is most appropriately accommodated in *Plagiobryum*.

Ochi (1968) first noted *B. wildii* from Australia, and he later placed it in the synonymy of *B. cellulare*. We have accepted this synonymy, but we recognise *Bryum cellulare* as being referable to *Plagiobryum.* Thus, *Plagiobryum* is represented in Australia by a single species.

H.Ochi, A revised list of the mosses of the family Bryaceae in Japan and adjacent regions, *J. Jap. Bot.* 20: 1–34 (1968); H.Ochi, A revision of the subfamily Bryoideae in Australia, Tasmania, New Zealand and adjacent islands, *J. Fac. Educ. Tottori Univ., Nat. Sci.* 21: 7–67 (1970).

Plagiobryum cellulare (Hook.) J.R.Spence & H.P.Ramsay, *Fl. Australia* 51: 411 (2006)

Bryum cellulare Hook., *Sp. Musc. Frond.*, Suppl. 3, 1: 214 (1827); *Brachymenium cellulare* (Hook.) A.Jaeger, *Ber. Tätigk. St. Gallischen Naturwiss. Ges.* 1873–74: 111 (1875) (Ad. 1: 573, 1876). T: "in Nepalensi [Nepal] regno lectum dedit, Pr. Hooker"; holo: BM.

Plagiobryum wildii Broth., *Oefvers. Förh. Finska Vetensk.-Soc.* 37: 101 (1891); *Bryum wildii* (Broth.) Müll.Hal., *Genera Musc. Frond.* 204 (1901); *Zieria wildii* (Broth.) Kindb., *Enum. Bryin. Exot.* 108 (1901). T: Highfields, Qld, Dec. 1888, *C.Wild s.n.*; holo: H-BR; iso: BM, BRI, MEL, NSW.

Brachymenium novaevalesiae Broth., *in* W.W.Watts & T.Whitelegge, *Proc. Linn. Soc. New South* Wales 30 (Suppl.): 124 (1906), *nom. nud*. (in synon.). Based on: Skinners Head, Ballina, N.S.W., *W.W.Watts 5370*, *5372*, *5700* (NSW).

Illustrations: A.Noguchi, *Illustr. Moss Fl. Japan* 457, fig. 199b (1988), as *Bryum cellulare*; A.Eddy, *Handb. Malesian Mosses* 3: 146, fig. 430 (1996), as *Bryum cellulare*.

Plants small and delicate, reddish to yellow-green. Stems short, to 30 mm tall; branches clavate in outline. Lower leaves small and remote; upper leaves erect-spreading, much larger and compact, ovate to oblong-ovate, 1.30–1.35 mm long, 0.7–1.0 mm wide, cymbiform, obtuse; margin incurved, entire; costa slender, reddish, short-excurrent or failing below apex; median laminal cells lax, rhomboidal- or elongate-hexagonal, with acute ends, 85–110 × 20–30 µm, thin-walled, forming an indistinct border of 2 rows of linear-rhomboidal cells; lower cells rectangular. Setae 0.7–1.5 mm long, often flexuose below, reddish brown. Capsules inclined to horizontal 1.0–1.5 mm long; apophysis shorter than urn, tapering to the seta; operculum convex, mucronate. Peristome: exostome teeth broad at base, transversely striolate and orange in lower half, indistinctly papillose and pellucid above; endostome segments linear,

somewhat shorter than exostome teeth, narrowly split; cilia absent; basal membrane smooth. Spores 20–26 µm diam. Chromosome number not known. Fig. 19L–S.

Occurs on wet rocks in W.A., eastern Qld and northern N.S.W.; possibly overlooked elsewhere as capsules are essential for positive identification. Also in Africa, Asia, Japan and Malesia. Map 186.

W.A.: Winnana Springs, Marble Downs Stn, E Kimberley, 13 May 1984, *J.H.Willis* (MEL). Qld: Carnarvon Natl Park via Rolleston, Mar. 1983, *W.Morley* (MEL); Carnarvon Natl Park, *I.G.Stone 20257* (MEL); Mickeys Ck, Carnarvon Gorge, *I.G.Stone 5034* (MEL).

This species differs from *P. novae-seelandiae* Broth., a New Zealand endemic (G.O.K. Sainsbury, *Bull. Roy. Soc. New Zealand* 5: 245–246, 1955), which is more closely allied to the Northern Hemisphere type species *P. zieri* (Hedw.) Lindb. *Plagiobryum novae-seelandiae* has sharply acuminate leaves, the capsule neck is as long as or longer than the urn and is strongly asymmetrical, whereas *P. cellulare* has ovate to oblong-ovate leaves with obtuse apices; the capsule neck is shorter than the urn and is less asymmetrical.

6. PTYCHOSTOMUM

Ptychostomum Hornsch., *Flora* 5, 2: syll. 62 (1822); from the Greek *ptyktos* (folded) and *stomum* (a mouth); reference uncertain.

Type: *P. pendulum* Hornsch.

Dioicous, synoicous or autoicous. Plants small to robust, in dense tufts or turfs. Stems erect, usually branched by perichaetial innovations, usually ±radiculose. Rhizoids usually pale or red to red-brown, papillose. Leaves generally smaller and remote below and larger and often comose above, erect or erect-spreading, usually not much altered when moist or dry, ±concave, usually rather broad, ovate or lanceolate to elliptic, sometimes narrowed at the base, and often decurrent, usually acute, rarely obtuse or rounded, frequently with a short or long acumen; margin smooth to serrate, often bordered with narrow elongate cells, sometimes bistratose; costa usually excurrent; upper laminal cells rhomboidal-hexagonal, rather broad and transparent; lower cells longer, narrower and rectangular; cells at stem insertion below alar region often inflated, reddish and forming a small auriculate group. Filiform gemmae rare in leaf axils. Setae solitary, reddish, flexuose, curved or hooked at tip. Capsules mostly nodding or pendent, smooth, subcylindrical, clavate or pyriform, rarely ovoid to subglobose, symmetrical or slightly curved; operculum hemispherical or convex-conical or mammillose. Peristome reduced to well developed; exostome teeth lanceolate, acuminate, fused at the extreme base, yellow to brown, hyaline at the tips, usually bordered; endostome pale, finely papillose; basal membrane variable; cilia 1–3, often nodulose or appendiculate, rudimentary or lacking. Spores 8–50 µm diam.

This is a large, predominantly Northern Hemisphere genus of 80–100 species. Five species are known in Australia.

Spence (2005) resurrected *Ptychostomum* for those species of Bryaceae with rhodobryoid laminal areolation, peristome reduction associated with nutant capsules, and a lack of asexual propagules other than occasional axillary filiform gemmae (e.g. *P. pseudotriquetrum*). *Ptychostomum* is further characterised by stems that are comose to elongate but not rosulate. Another useful character is the presence of an inflated, auriculate group of cells in the alar region of comal leaves (Spence, 2005). More than in any other genus of Bryaceae, the species in *Ptychostomum* are notoriously difficult to identify and, for some species, capsules with peristomes are essential.

J.R.Spence, New genera and combinations in Bryaceae (Bryales, Musci) for North America, *Phytologia* 87: 15–28 (2005); J.R.Spence & H.P.Ramsay, New genera and combinations in the Bryaceae (Bryales, Musci) for Australia, *Phytologia* 87: 61–71 (2005).

1 Synoicous; peristome reduced, with a low basal membrane; cilia usually short; spores mostly > 20 µm diam. ....**1. P. altisetum**

1: Dioicous or synoicous; peristome well developed; spores < 20 µm diam. 2

2 Plants 1–5 (–10 cm) tall; stems elongate, with equidistant decurrent leaves, usually strongly tomentose, sparingly branched; laminal cells distinctly incrassate; costa percurrent to short-excurrent; leaf border strong; upper margin denticulate *(1:)* .... **5. P. pseudotriquetrum**

2: Plants to 3 cm tall; leaves densely tufted, comose, not decurrent, tomentose below; laminal cells mostly thin-walled; costa short- to more commonly long-excurrent; leaf border variable, sometimes weak; upper margin usually entire or finely serrulate..3

3 Synoicous; leaf border distinct *(2:)*.. **3. P. creberrimum**

3: Dioicous; leaf border weak or almost lacking..4

4 Leaves ovate to ovate-lanceolate; upper and middle laminal cells elongate, 50–70 × 10–12 µm (5–6: 1) *(3:)* .... **2. P. angustifolium**

4: Leaves ovate to obovate; upper and middle laminal cells shorter and broader, 30–60 × 12–18 µm (3–4: 1) .... **4. P. cylindrothecium**

1. Ptychostomum altisetum (Müll.Hal.) J.R.Spence & H.P.Ramsay, *Phytologia* 87: 63 (2005)

Bryum altisetum Müll.Hal., *Hedwigia* 37: 96 (1898). T: Moyston, Vic., Oct. 1883, *D.Sullivan 551*; lecto: H, *fide* H.Ochi, *J. Fac. Educ. Tottori Univ. Nat. Sci.* 21: 43 (1970); Dimboola, Vic., Oct. 1893, *F.M.Reader 4*; syn: H; near Hot Springs, Yarrangobilly Caves, N.S.W., *W.W.Watts 8565*; syn: NSW.

Bryum humilisetum Müll.Hal., *Hedwigia* 37: 97 (1898), *nom. inval.* (in synon.); *Bryum altisetum* Müll.Hal. var. *humilisetum* Müll.Hal., *Hedwigia* 37: 96 (1898). T: Moyston, Vic., Oct. 1883, *D.Sullivan 14d*; holo: MEL.

[*Bryum inclinatum auct. non* (Brid.) Bland: D.G.Catcheside, *Mosses of South Australia* 253 (1980)]

Illustrations H.Ochi, *J. Fac. Educ. Tottori Univ. Nat. Sci.* 21: 44, fig. 25 (1970), as *Bryum altisetum*; A.J.E.Smith, *Moss Flora of Britain and Ireland* 398, fig. 187 (6–11) (1978), as *Bryum inclinatum*; D.G.Catcheside, *Mosses of South Australia* 254, fig. 145 (1980), as *Bryum inclinatum.*

Synoicous. Plants to 10 mm tall, loosely to densely tufted, yellowish green. Leaves crowded above in comal tufts, appressed and straight to somewhat crisped when dry, erecto-patent when moist, ovate-lanceolate to oblong-lanceolate, 1.5–3.0 mm long, not or weakly decurrent, acuminate; base of leaf reddish; leaves of sterile innovations somewhat smaller and imbricate, concave; margin recurved, finely denticulate above, bordered by 3 or 4 rows of very narrow incrassate cells; costa short- to long-excurrent, yellowish to brown; upper and middle laminal cells 40–70 × 10–15 µm (3–4: 1), thin-walled; basal cells long-rectangular; angular cells at insertion of comal leaves inflated and reddish. Setae slender, 10–20 mm long. Capsules inclined to pendulous, narrowly pyriform, 1.5–3.5 mm long, symmetrical; mouth yellowish; operculum mammillose. Peristome reduced; exostome teeth reddish below, yellow above, with lamellae; endostome segments with broad perforations, papillose along mid-line; basal membrane low; cilia rudimentary or 1 or 2 and short. Spores 18–25 µm diam. Chromosome number not known. Fig. 36L–R.

Occurs in N.S.W., A.C.T. and Vic., possibly also in New Zealand. Grows in tufts on soil and rock, predominantly subalpine to alpine in Australia. Map 187.

N.S.W.: Yarrangobilly Caves, *A.J.Downing s.n.* (NSW); *loc. id.*, *W.W.Watts 8551* (NSW); Snowy Mtns, *D.G.Catcheside 54.70* (AD). A.C.T.: Warks Rd, Brindabella Ra., *H.Streimann 4749* (CANB). Vic.: Echo Flat, Lake Mtn, near Marysville, *J.H.Willis 77* (MEL).

Ptychostomum altisetum is most similar to *Bryum inclinatum*, a widespread, montane species in the Northern Hemisphere. However, there are subtle differences between the two species in leaf and peristome characters, and we prefer to maintain *P. altisetum* as a distinct species pending a worldwide revision.

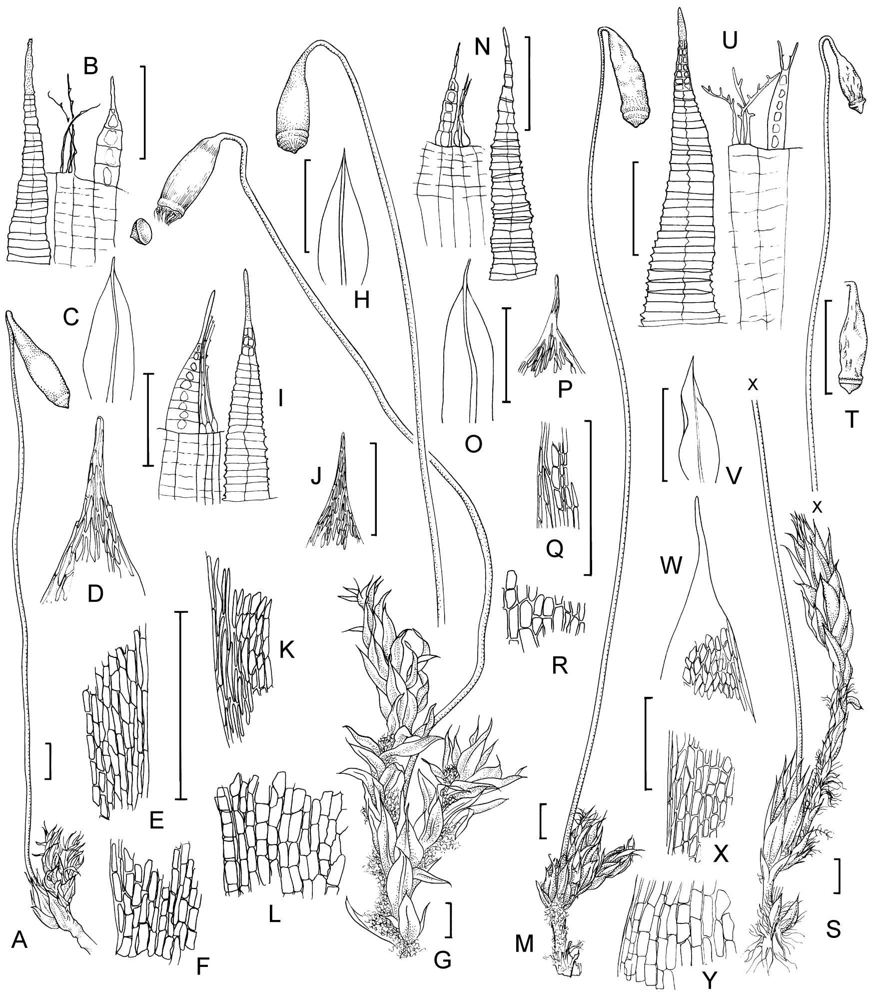

Figure 44. *Ptychostomum*. **A–F**, *P. angustifolium*. **A**, Habit with sporophyte (dry specimen); **B**, Peristome: exostome tooth (left); endostome basal membrane with cilia and segment (right); **C**, Leaf; **D**, Cells at leaf apex; **E**, Mid-leaf cells; **F**, Basal leaf cells (A–F, *W.W.Watts 8625*, NSW). **G–L**, *P. creberrimum*. **G**, Habit with sporophyte (dry specimen); **H**, Leaf; **I**, Peristome; **J**, Cells at leaf apex; **K**, Mid-leaf cells; **L**, Basal leaf cells (G–L, *H.T.Clifford s.n.*, MEL). **M–R**, *P. cylindrothecium*. **M**, Habit with sporophyte (dry specimen); **N**, Peristome: endostome basal membrane with segment and cilia (left); exostome tooth (right); **O**, Leaf; **P**, Cells at leaf apex; **Q**, Mid-leaf cells; **R**, Basal leaf cells (M–R, *H.B.Womersley s.n.*, AD). **S–Y**, *P. pseudotriquetrum*. **S**, Habit with sporophyte (dry specimen) (*F.Mueller s.n.*, MEL 25997); **T**, Capsule; **U**, Peristome: exostome tooth (left); endostome with high basal membrane, segment and cilia (right); **V**, Leaf; **W**, Upper laminal cells and apex; **X**, Mid-leaf cells; **Y**, Basal leaf cells (S–Y, *D.G.Catcheside 54.66*, AD). Scale bars: 1 mm for habit; 0.5 mm for leaves, 100 µm for cellular drawings. Drawn by C.Wardrop.

2. Ptychostomum angustifolium (Brid.) J.R.Spence & H.P.Ramsay, *in* J.R.Spence, *Phytologia* 87: 23 (2005)

Bryum angustifolium Brid., *Muscol. Recent*., Suppl. 3: 31 (1817). T: Germany; *n.v.*

Bryum caespiticium Hedw., *Sp. Musc. Frond.* 180 (1801), *non Ptychostomum caespiticium* Brid., *Bryol. Univ.* 1: 837 (1827). T: Europe; *n.v.*

Bryum caespiticium Hedw. var. *crinitum* Wilson, *in* J.D.Hooker, *Fl. Tasman*. 2: 191 (1859). T: Hobarton [Hobart], Tas., *R.C.Gunn 24*; syn: BM; Port Sorrell, Tas., *W.Archer*; syn: BM.

Bryum laxirete Broth., *Proc. Linn. Soc. New South Wales* 41: 588 (1916). T: Emu Plains, N.S.W., *W.Forsyth 1019*; syn: H-BR; Warrumbungle Ra., N.S.W, *W.Forsyth 1022*; syn: H-BR; Jenolan Caves, N.S.W., *Blakely 970*; syn: H-BR; isosyn: NSW; Hill Top, N.S.W., *J.H.Maiden 406*; isosyn: NSW; near Barbers Creek, N.S.W., *W.Forsyth 409*. syn: H-BR.

Bryum capitellatum Müll.Hal. ex Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 130 (1906), *nom. nud*. Based on: Vic., 2 Aug. 1896, *F.M.Reader* (MEL).

Illustrations: H.C.Gangulee, *Mosses of Eastern India and Adjacent Regions* 2: 996, fig. 483 (1974); A.J.E.Smith, *Moss Flora of Britain and Ireland* 413, fig. 196 (1–4) (1978); D.G.Catcheside, *Mosses of South Australia* 265, fig. 154 (1980), all as *Bryum caespiticium.*

Dioicous. Plants 10–20 mm tall, densely tufted, pale bright silky green above, brownish-tomentose below. Stems slender, comose, with slender innovations. Leaves scarcely or slightly twisted when dry, imbricate, erect when moist; uppermost leaves forming a crowded coma, ovate to oblong lanceolate, widest below middle, not decurrent, acuminate; innovation leaves smaller, ovate and strongly concave; margin revolute almost to apex, ±entire; marginal cells narrow but not forming a distinct border; costa usually excurrent in a long entire arista, yellowish to reddish brown; laminal cells narrowly hexagonal to rhomboidal, 50–70 × 10–12 µm (5–6: 1), thin-walled; basal cells long rectangular; angular walls of alar region of comal leaves swollen, pinkish. Setae slender, 10–20 mm long. Capsules oblong-pyriform or clavate, 2.0–2.5 mm long, cernuous or pendulous; apophysis thick, often somewhat gibbous, shorter than urn, tapering to the seta; mouth wide; operculum, convex, slightly apiculate. Exostome teeth pale brown; endostome segments broadly perforate; basal membrane high, half the length of the exostome; cilia 2, long-appendiculate. Spores 10–16 µm diam. $n = 30$, *fide* H.P.Ramsay & J.R.Spence, *J. Hattori Bot. Lab*. 80: 260 (1996), as *Bryum caespiticium*; "$n = 20$" is an error.

Occurs in W.A., N.T., S.A., N.S.W., A.C.T. Vic. and Tas.; common on dry sandy or silty soils and rocks especially in mallee or sclerophyll scrub. A ±cosmopolitan species in temperate regions, but rare in the tropics. Map 188.

W.A.: Wansborough Walk to Granite Domes, Porongurup Natl Park, *J.R.Spence 4196* (NSW). N.T.: Kakadu Natl Park, *L.A.Craven 6145A* (CANB). S.A.: Glenelg R., *D.G.Catcheside 55.130* (AD). N.S.W.: Warrumbungle Ra., *W.Forsyth 1022* (NSW). A.C.T.: Two Sticks Rd, near Piccadilly Circus, Brindabella Ra., *N.T.Burbidge 7065* (CANB). Vic.: Manna Falls, near Hamilton, *H.P.Ramsay 8/77*, *9/77* (NSW).

The elongate, thin-walled laminal cells, the absence of a distinct leaf border, and the long-excurrent hairpoint are diagnostic.

3. Ptychostomum creberrimum (Taylor) J.R.Spence & H.P.Ramsay, *in* J.R.Spence, *Phytologia* 87: 23 (2005)

Bryum creberrimum Taylor, *London J. Bot*. 5: 54 (1846). T: Swan River, W.A., *J.Drummond s.n.*; holo: BM.

Bryum affine Schultz, *Flora* 54: 476 (1871), *nom. illeg.* (later homonym). T: Swan R., W.A., *J.Drummond s.n.*; holo: *n.v.*

[*Bryum intermedium auct. non* (Brid.) Bland: H.Streimann & N.Klazenga, *Cat. Austral. Mosses* 33 (2002)]

Illustrations: A.J.E.Smith, *Moss Flora of Britain and Ireland* 410, fig. 194 (5–8) (1978); D.G.Catcheside, *Mosses of South Australia* 255, fig. 146 (1980), both as *Bryum intermedium.*

Synoicous. Plants 10–30 mm tall, densely tufted, yellow-green above, reddish brown below, tomentose. Stems comose, branched. Leaves erecto-patent when moist, a little twisted when dry, lanceolate to ovate-lanceolate, not decurrent, tapering to an acuminate apex; margin strongly recurved, entire or denticulate near apex; costa reddish, excurrent in a short point; middle and upper laminal cells rhomboidal to hexagonal, 40–70 × 10–15 µm (3–4: 1), thin-

walled; several marginal rows of longer narrower more incrassate cells forming a distinct border; basal cells long-rectangular; cells in lower alar region of comal leaves inflated, reddish. Setae slender, 15–30 mm long. Capsules inclined to pendulous, symmetrical, narrowly pyriform, 2.5–3.5 mm long; operculum mammillose. Peristome well developed; exostome teeth narrowly lanceolate, brownish red; endostome segments with long perforations, c. as wide as long; basal membrane to c. half the height of the teeth; cilia 2, appendiculate. Spores 14–16 µm diam. n = 30, *fide* H.P.Ramsay & J.R.Spence, *J. Hattori Bot. Lab.* 80: 260 (1996), as *Bryum creberrimum*. Fig. 44G–L.

Widespread in W.A, S.A., N.S.W., A.C.T., Vic. and Tas.; uncommon on soil or in rock crevices, prefers sandy, basic substrata. A pantemperate species in both hemispheres. Map 189.

W.A.: Two Peoples Bay Nature Reserve, 30 km E of Albany, *R.Wyatt & A.Stoneburner 3769* (PERTH). S.A.: Lees Springs, *D.G.Catcheside 54.38* (AD). N.S.W.: trail above Blue L., Charlotte Pass, Kosciuszko Natl Park, *J.R.Spence 4748* (NSW). A.C.T.: Brumby Flats, Brindabella Ra., *L.Craven 545* (CANB). Vic.: Bogong High Plains, *J.H.Willis s.n.* (MEL). Tas.: Orford, 23 Sept. 1984, *D.G.Catcheside* (AD).

Ptychostomum creberrimum can be distinguished by its synoicous perichaetia, elongate thin-walled laminal cells, leaf border and usually short-excurrent costa. This is very similar to the Northern Hemisphere species *Bryum lisae* De Not.

4. Ptychostomum cylindrothecium (R.Br.ter.) J.R.Spence & H.P.Ramsay, *Phytologia* 87: 63 (2005)

Bryum cylindrothecium R.Br.ter., *Trans. & Proc. New Zealand Inst.* 31: 452 (1899). T: Waikari, New Zealand, Apr. 1882, *R.Brown*; holo: CHR.

Dioicous. Plants in dense tufts to 15 mm tall, yellowish green above. Stems branched by a few perichaetial innovations, brownish-tomentose below. Leaves crowded in the upper part of the stem; lower leaves closely imbricate when dry, not much altered when moist, ovate or obovate with an acute apex and a non-decurrent base, to 1.5 mm long, strongly concave, innovation leaves smaller; margin plane or slightly reflexed in median to basal parts, entire; costa strong, long-excurrent with an arista, red towards the base; laminal cells thin-walled, hexagonal or rhomboidal-hexagonal, to 30–60 × 12–18 µm (3–4: 1); basal cells rectangular, indistinctly bordered by 1 or 2 rows of thin-walled more elongate cells; alar region of slightly inflated pinkish cells. Setae slender, erect, to 15–20 mm long. Capsules nutant to subpendulous, oblong-pyriform, 3.0–3.5 mm long, pale brown; operculum convex, slightly apiculate. Peristome well developed; exostome teeth pale brown; endostome segments perforate; basal membrane high, half the length of the exostome; cilia 2 or 3, appendiculate. Spores 10–12 µm diam. Chromosome number not known. Fig. 44M–R.

Occurs on sandy soil in southern S.A.; also in New Zealand. Reported here for the first time from Australia. Map 190.

S.A.: Kangaroo Is., 28 Aug. 1948, *H.B.S.Womersley* (AD); Coorong, opposite Campbell Pt, *V.Levitzke 968* (AD).

Ptychostomum cylindrothecium can be separated from *P. angustifolium* by its distinctive leaf shape and broader laminal cells.

5. Ptychostomum pseudotriquetrum (Hedw.) J.R.Spence & H.P.Ramsay, *in* J.R.Spence, *Phytologia* 87: 23 (2005)

Mnium pseudotriquetrum Hedw., *Sp. Musc. Frond.* 190 (1801); *Bryum pseudotriquetrum* (Hedw.) Schwägr., *Sp. Musc.*, Suppl. 1, 2: 110 (1816). T: Europe; *n.v.*

Bryum ventricosum Dicks. ex Relh., *Fl. Cantab*. 2nd edn, 427 (1802), *nom. illeg.* T: Europe; *n.v.*

Bryum tasmanicum Hampe, *Linnaea* 25: 714 (1853). T: Van Diemensland, [Tas.], 1850, *Stuart*; holo: BM; iso: MEL.

Bryum rubiginosum Hook.f. & Wilson, *in* J.D.Hooker, *Fl. Tasman.* 2: 190 (1859). T: St. Patricks, Tas., *R.C.Gunn*; holo: MEL.

Bryum austroaffine Broth., *Proc. Linn. Soc. New South Wales* 41: 587 (1916). T: Yarrangobilly Caves, N.S.W., *W.Forsyth 1012*, *1014*; syn: H-BR; isosyn: NSW; Kiandra, N.S.W., *W.Forsyth 1010, 1011*; syn: H-BR; isosyn: MEL, NSW.

Bryum subventricosum Broth., *Proc. Linn. Soc. New South Wales* 41: 586 (1916). T: Tumbarumba, N.S.W., *W.Forsyth 725*; holo: H-BR; iso: NSW.

Bryum subpseudotriquetrum Broth. ex Burges, *Proc. Linn. Soc. New South Wales* 60: 93 (1935), *nom. nud.* Based on: Tumbarumba, N.S.W., *W.Forsyth 725* (NSW).

Illustrations: H.Ochi, *J. Fac. Educ. Tottori Univ. Nat. Sci*. 21: 45, fig. 26A–F (type of *Bryum tasmanicum*); G–J (syntype of *Bryum austroaffine*); 46, fig. 27A–G (type of *Bryum subventricosum*); H (*Bryum rubiginosum*) (1970); D.G.Catcheside, *Mosses of South Australia* 260, fig. 150 (1980), as *Bryum pseudotriquetrum*; R.D.Seppelt, *The Moss Flora of Macquarie Island* 109 fig. 42 (2004), as *Bryum pseudotriquetrum*.

Dioicous in Australia. Plants 1–5 (–10) cm tall, in dense tufts or open mats, glossy, greenish to reddish. Stems densely matted below with red-brown rhizoids. Leaves uniform and equidistant on stem, crowded at apex, shrunken when dry, erecto-patent when moist, ovate to ovate-lanceolate, 2.0–3.5 mm long, decurrent, acute; margin recurved, denticulate above, decurrent; costa stout, percurrent to short-excurrent, reddish brown; upper laminal cells broadly hexagonal, 20–40 × 12–20 µm (2–3: 1), incrassate; elongate marginal cells forming a distinct border; basal cells short- to long-rectangular, reddish; alar region of comal leaves with a group of larger inflated cells. Setae slender, mostly straight, 10–30 mm long. Capsules ±pendulous, broadly pyriform, 3.0–4.5 mm long; operculum conical. Peristome well developed; exostome teeth orange-brown below, papillose at tips; endostome segments broadly perforate; basal membrane half the height of the exostome; cilia 2 or 3, filiform, long-appendiculate. Spores 12–18 µm diam., finely papillose. Chromosome number not known. Fig. 44S–Y.

Occurs in N.S.W, A.C.T., Vic. and Tas. A plant of wet soils, fens, wet heaths and marshes, usually low-alpine, but also in lowland acidic marshes. Also in Europe, Asia, North and South America, West Africa, New Zealand and Antarctica. Map 191.

N.S.W.: Mt Kosciuszko, *D.G.Catcheside 54.66* (AD). A.C.T.: Tidbinbilla, 18 Mar. 1975, *D.G.Catcheside* (NSW). Vic.: Bogong High Plains, 17 Jan. 1970, *M.Blackwood* (AD). Tas.: Mt Wellington, *A.V.Ratkowsky H573* (CANB).

Ptychostomum pseudotriquetrum is characterised by its comparatively large size, the elongate, densely tomentose stems, decurrent leaves with a short, stout point and broad, incrassate upper laminal cells. Northern Hemisphere populations occasionally produce filiform gemmae in the leaf axils as in *Rosulabryum*, and also include shorter, comose synoicous forms that have not been seen in Australia. *Gemmabryum laevigatum* often grows with *P. pseudotriquetru*m, but it is readily distinguished by its obtuse leaves, extremely dense areolation, and the absence of dense tomentum on the stems.

7. RHODOBRYUM

Rhodobryum (Schimp.) Limpr., *Laubm. Deutschl*. 2: 444 (1892), *nom. cons.*; from the Greek *rhodo* (rose-) and *bryon* (a moss), in reference to the terminal rosettes of leaves present in most species.

Bryum subg. *Rhodobryum* Schimp., *Syn. Musc. Eur*. 381 (1880).

Type: *R. roseum* (Hedw.) Limpr.

Dioicous. Plants large, in dense turfs on damp soil or mud in open or partly shaded habitats. Stems arising from underground stolons, unbranched or sparingly branched by subperichaetial innovations, not tomentose below. Rhizoids sparse, arising from leaf axils, red. Leaves large, equidistant along stem, erect and contorted or shrivelled when dry, only weakly hygroscopic, obovate or spathulate, usually in enlarged rosettes at stem apices, rarely with comal tufts; lower leaves usually reduced and distant, rarely leaves equidistant along stem and not reduced below; margin serrate, usually bordered by 1 or more rows of elongate thick-walled cells; costa single, excurrent, in cross-section with several layers of ventral cells; dorsal stereid band lacking or poorly developed; upper laminal cells rhomboidal (2–4: 1); lower laminal cells regularly rectangular, longer than upper cells. Gemmae lacking. Perigonia and perichaetia terminal; leaves slightly differentiated, larger than vegetative leaves; perichaetia often polysetose. Setae long. Capsules long-exserted, pendulous, oblong-cylindrical, often

somewhat curved; operculum conical. Peristome double; exostome teeth 16, linear to lanceolate, trabeculate, hyaline, papillose above, irregularly papillose to cross-striolate below; endostome segments 16, broadly keeled; basal membrane high; cilia 2 or 3, appendiculate. Spores small. n = 10, 11, *fide* R.Fritsch, *Bryophyt. Biblioth.* 40: 253 (1991).

A genus of 25–30 species which is most diverse in the montane tropics and subtropics, especially in Africa, Malesia and South America. Six species are known from SE Asia and India, three of which occur in New Guinea. The genus is represented in Australia by a single somewhat aberrant species, *R. aubertii*. Principal distinguishing characteristics between species are gametophytic, sporophytes tending to be uniform in the genus.

Ochi (1992) included *Rhodobryum* within his broad concept of *Bryum*. We follow Iwatsuki & Koponen (1972) and Mohamed (1984) in accepting it as a separate genus based on morphological and cytological data, a position that is supported by many bryologists. *Rhodobryum* is closely related to *Rosulabryum* from which it can be distinguished by the presence of stolons, stereids that are reduced or absent in the costa, the prevalence of polysety, the absence of asexual gemmae, very large chromosomes, and a tendency for the leaves to absorb water comparatively slowly. This last character is shared by some members of the Mniaceae, such as *Plagiomnium*. Superficially, *Rhodobryum* and *Plagiomnium* are very similar.

Z.Iwatsuki & T.Koponen, On the taxonomy and distribution of *Rhodobryum roseum* and its related species (Bryophyta), *Acta Bot. Fenn.* 96: 1–22 (1972); M.A.Haji Mohamed, *Rhodobryum commersoni* (Schwägr.) Par. and *R. aubertii* (Schwägr.) Thér. in south India, *J. Bryol.* 11: 691–694 (1981); M.A.Haji Mohamed, A synopsis of the genus *Rhodobryum* in Asia, *J. Hattori Bot. Lab.* 55: 281–293 (1984); H.Ochi, A revised infrageneric classification of the genus *Bryum* and related genera (Bryaceae, Musci), *Bryobrothera* 1: 231–244 (1992).

Rhodobryum aubertii (Schwägr.) Thér., *Recueil Publ. Soc. Havraise Études Diverses* 89(2): 128 (1922)

Mnium aubertii Schwägr., *Sp. Musc. Frond.*, Suppl. 1, 2: 132, 180 (1816); *Bryum aubertii* (Schwägr.) Brid., *Muscol. Recent.*, Suppl. 4: 119 (‘1819’) [1818]. T: Insula Franciae [Madagascar], *Aubert s.n.*; holo: G.

Bryum graeffeanum Müll.Hal., *J. Mus. Godeffroy* 3: 63 (1874); *Rhodobryum graeffeanum* (Müll.Hal.) Paris, *Index Bryol.* 1116 (1897). T: Ovalau Is., Fiji, *Graeffe s.n.*; holo: NY.

Rhodobryum olivaceum Hampe, *Linnaea* 40: 311 (1876); *Bryum olivaceum* (Hampe) Mitt., *Fragm.* 11 (Suppl.): 48 (1881). T: subtropical East Australia, *Evans s.n.*; holo: BM.

Bryum subcrispatum Müll.Hal., *Enum. Bryin. Exot.* 106 (1891); *Rhodobryum subcrispatum* (Müll.Hal.) Műll.Hal., *Hedwigia* 37: 101 (1898). T: Richmond R., N.S.W., 1885, *Mrs Hodgkinson s.n.*; syn: MEL? (not located); Brisbane, Qld, *F.M.Bailey*; syn: H-BR.

Bryum humipetens Müll.Hal., *Hedwigia* 37: 101 (1898). T: Brisbane, Qld, *F.M.Bailey ‘348*’; H-BR *n.v.*, *fide* P.Isoviita & T.Koponen, *Taxon* 33: 738 (1984).

Rhodobryum subcrispatulum Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 144 (1906), *nom. nud.* (in synon.). Based on: Woolston scrub, Qld, Aug. 1888, *C.Wild s.n.* (NSW).

Illustrations: H.Ochi, *J. Fac. Educ. Tottori Univ., Nat. Sci.* 21: 61–63, figs 39–41 (1970), as *R. graeffeanum* and *R. leucocanthum*; T.Koponen & D.H.Norris, *Ann. Bot. Fenn.* 21: 284, fig. 7 (1984); A.Eddy, *Handb. Malesian Mosses* 3: 155, fig. 437 (1996).

Plants 10–30 mm tall, often reddish. Upper leaves equidistant along stem, somewhat more crowded above (not strongly rosulate), not much reduced in size towards stem base, obovate to ovate, 6–8 (–9) mm long; margin coarsely serrate from below mid-leaf to apex; leaf border variable above, often weak or ±lacking, well developed in lower half of lamina, revolute towards base; costa percurrent to excurrent, strongly prominent abaxially, in section with median thin-walled parenchyma, lacking stereids; upper laminal cells rhomboidal; lower cells rectangular. Perichaetial leaves slightly differentiated; male plants a little smaller. Setae 1–several per perichaetium, 30–60 mm long. Capsules pendulous, oblong-cylindrical, to 6 mm long. Exostome teeth lanceolate; endostome segments slightly shorter than teeth; cilia 2 or 3. Spores 10–20 µm. n = 10 (Papua New Guinea), *fide* H.P.Ramsay & J.R.Spence, *J. Hattori Bot. Lab.* 80: 251–270 (1996). Fig. 45.

A rare species of wet-tropical and subtropical rainforest in Qld and N.S.W.; also in Lord Howe Is. and southern India. Found at moderately high elevations (500–1000 m), usually in depressions along streams and roads, also on wet soil. The moss seems to favour low areas where water temporarily accumulates. Map 192.

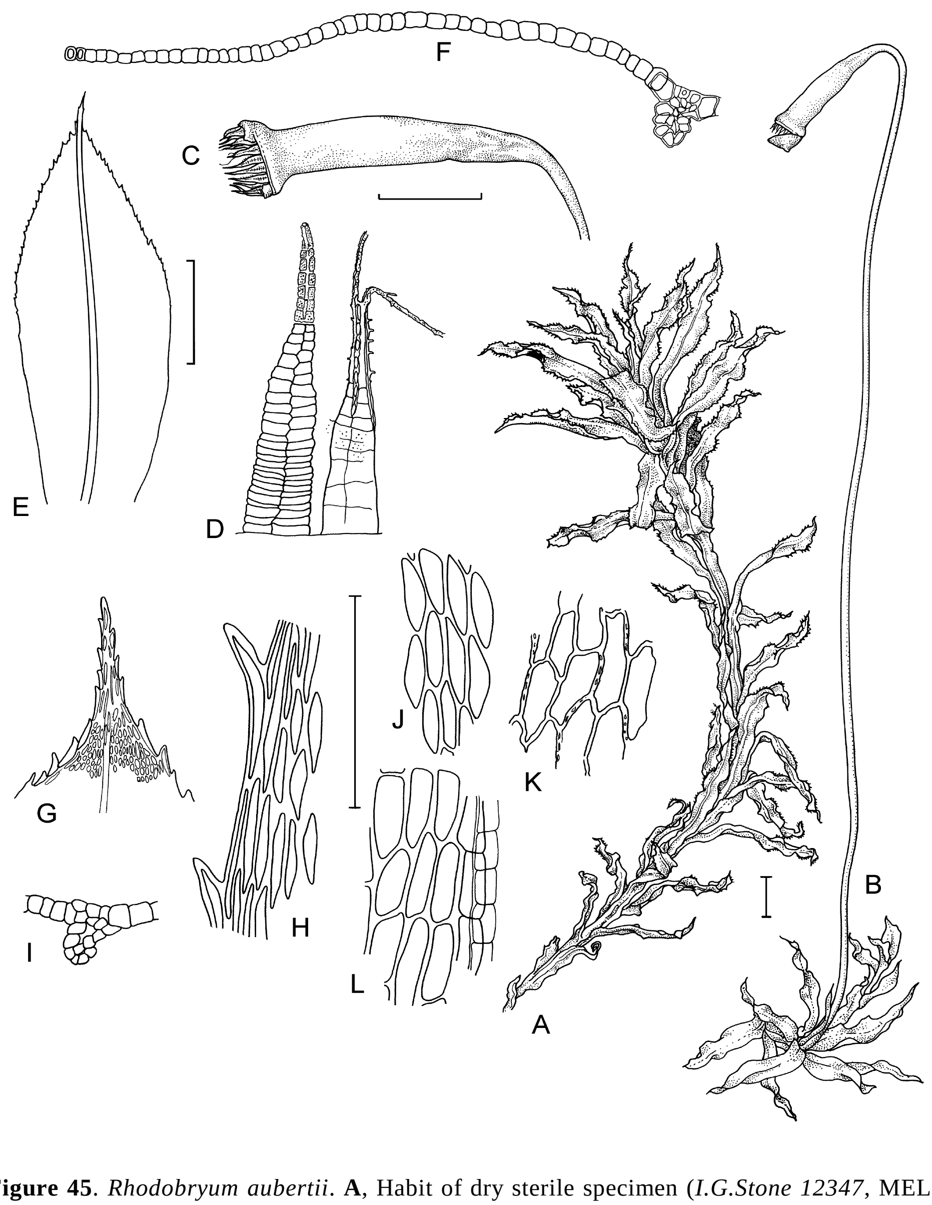

Figure 45. *Rhodobryum aubertii*. **A**, Habit of dry sterile specimen (*I.G.Stone 12347*, MEL); **B**, Dry specimen with sporophyte; **C**, Capsule showing peristome; **D**, Peristome: exostome tooth (left); endostome segment and cilium (right); **E**, Leaf; **F**, T.S. of half of leaf; **G**, Cells at leaf apex; **H**, Marginal cells at mid-leaf; **I**, T.S. of leaf costa; **J**, Upper laminal cells; **K**, Mid-laminal cells; **L**, Basal laminal cells (B–L, *W.B.Schofield 80391*, NSW). Scale bars: 10 mm for habit; 1 mm for enlarged capsule; 0.5 mm for leaf; 100 µm for cellular drawings. Drawn by L.Elkan.

Qld: Eungella Natl Park, *I.G.Stone 12347* (MEL); Eungella Natl Park, *W.B.Schofield 80391* (NSW); Mt Lewis, *J.R.Spence 5111* (NSW); Mt Glorious *K.Barton 65* (BRI). N.S.W.: Myocum, *W.W.Watts 1518* (NSW).

Rhodobryum aubertii differs from most members of the genus in that it is not strongly rosulate, with the leaves clustered in a comal tuft but not forming a rosette. Instead, the leaves are arranged equidistantly along the stem, although somewhat closer above, and they do not become smaller below. It is also distinctive due to its large size and dull dark green leaves with sharp marginal teeth; the leaves are strongly contorted when dry and do not hydrate quickly.

Sporophytes are not always present, but when they are produced they occur *en masse*.

8. ROSULABRYUM

Rosulabryum J.R.Spence, *Bryologist* 99: 222 (1996); from the Latin *rosula* (a rosette) and the Greek *bryon* (a moss), in reference to the leaves being clustered in rosettes.

Type: *R. albolimbatum* (Hampe) J.R.Spence

Dioicous or rarely synoicous or polyoicous. Plants small to large; stems 0.5–10 cm tall, branched by subfloral innovations, in open turfs. Stems mostly strongly rosulate, often densely radiculose, with coloured papillose rhizoids. Leaves ovate, obovate to spathulate, variously contorted to spirally twisted around the stem when dry; upper margin denticulate to serrate by projecting cell ends or, occasionally, with distinct cellular teeth; costa strong, usually excurrent, in cross-section with a well-developed band of stereids; guide cells in 1 (or 2) layers; upper and mid-laminal cells short-rhomboidal (3–5: 1), sometimes porose, progressively rectangular and somewhat longer below, usually with a border of thickened elongate cells. Gemmae as axillary uniseriate filaments in some species; rhizoidal tubers usually present. Inner perichaetial and perigonial leaves somewhat differentiated, generally smaller than vegetative leaves. Setae solitary or sometimes polysetose and clustered, slender, elongate, smooth. Capsules clavate to pyriform, often somewhat arcuate, nutant to inclined; operculum conical. Peristome rather uniform, double; exostome teeth 16, irregularly striate on outer surface; endostome segments 16, the same height as the exostome, broadly perforated; basal membrane high, 33–67% the length of the exostome, papillose; cilia 2 or 3, appendiculate. Spores 8–25 µm diam. n = 10, 11, 20, polyploid series in synoicous species, *fide* R.Fritsch, *Bryophyt. Biblioth.* 40: 1–352 (1991), as various *Bryum* spp.; H.P.Ramsay & J.R.Spence, *J. Hattori Bot. Lab*. 80: 260–262 (1996).

Rosulabryum comprises the rosulate species of *Bryum s. lat.* with unreduced peristomes, generally obovate leaves with serrate margins, rhizoidal tubers and, occasionally, filiform gemmae in the leaf axils. The genus includes c. 75–100 species, of which 14 (five endemic) occur in Australia. One species included in the following key, *R. perlimbatum* Cardot, has not yet been found in Australia, although it is known from the South Island of New Zealand and Subantarctic islands. The genus exhibits a primary radiation within the tropics and subtropics, and it is especially diverse in Africa. *Rosulabryum* is related to *Brachymenium*, and while *Rhodobryum* is superficially similar, recent molecular studies suggest it is not closely related to *Rosulabryum* (Pedersen *et al.*, 2003).

H.Syed, A taxonomic study of *Bryum capillare* Hedw. and related species, *Bryologist* 77: 265–326 (1973); M.A.Haji Mohamed, A taxonomic study of *Bryum billarderi* Schwägr. and related species, *J. Bryol*. 10: 401–465 (1979); M.A.Haji Mohamed, *Bryum wightii* Mitt. and related species, *J. Bryol*. 12: 23–29 (1982); J.R.Spence, *Rosulabryum* genus novum, *Bryologist* 99: 221–225 (1996); H.P.Ramsay & J.R.Spence, Chromosome studies on Australasian Bryaceae, *J. Hattori Bot. Lab*. 80: 251–270 (1996); J.R.Spence & H.P.Ramsay, Three new species of *Rosulabryum* (Bryopsida) from Australia, *Telopea* 8: 325–335 (1999); N.Pedersen, C.J.Cox & L.Hedenäs, Phylogeny of the moss family Bryaceae inferred from chloroplast DNA sequences and morphology, *Syst. Bot.* 28: 471–482 (2003).

1 Filiform gemmae usually present in leaf axils of sterile stems 2

1: Filiform gemmae absent or rare 4

2 Stems with equidistant leaves, not rosulate; leaves ovate, rarely obovate; upper margin serrulate or entire; costa percurrent or short-excurrent as a mucro; epiphytic *(1)*..................... **5. R. epiphyticum**

2: Stems short and rosulate or, if elongate, the leaves strongly coarsely serrate; leaves mostly obovate; upper margin distinctly serrate; costa not reaching apex, percurrent or excurrent; on soil, rock or decaying wood 3

3 Leaves strongly keeled, narrowly ovate to spathulate, sharply serrate in upper half; filamentous gemmae with ±smooth walls *(2:)*.. **6. R. lamingtonicum**

3: Leaves flat when moist, broadly obovate, serrate near apex; filamentous gemmae coarsely papillose ....**1. R. albolimbatum**

4 Laminal cells elongate, to 125 µm long and 6–8: 1; rhizoidal tubers flattened, with strongly projecting cell walls *(1:)*.. **13. R. tuberosum**

4: Laminal cells mostly shorter and/or broader, generally < 80 µm long and 2–6: 1; tubers globose, with cell walls not projecting, or tubers absent...5

5 Polyoicous; leaves contorted when dry, only rarely spirally twisted around stem; tubers bright orange or crimson *(4:)*.. **12. R. torquescens**

5: Dioicous; leaves variously contorted, twisted or imbricate when dry; tubers mostly red-brown, rarely red to orange...6

6 Most leaves < 3 mm long, sometimes spirally twisted around stem; tubers mostly < 300 µm wide *(5:)* 7

6: At least some leaves 4–10 mm long or longer, contorted but not spirally twisted around stem, or sometimes imbricate; tubers mostly > 500 µm wide 11

7 Stems to 10 mm long; leaves to 1 mm long, rosulate, ovate; border weak or absent above; rhizoidal tubers mostly < 1.5 mm long, reddish brown, irregularly globose, elliptic or pyriform *(6)* ....**9. R. queenslandicum**

7: Stems more than 10 mm long, if shorter leaves serrate distally; leaves 1–3 mm long, obovate or, if ovate, the upper laminal cells elongate (4–6: 1); tubers > 100 µm, usually globose..............................8

8 Leaves keeled, narrowly ovate-lanceolate or spathulate, not rosulate except for perichaetial and perigonial buds; margin distinctly serrate in upper half of leaf; rhizoidal tubers brownish *(7:)*........... ....**6. R. lamingtonicum**

8: Leaves flat, not keeled, obovate to ovate, serrate to almost entire; teeth only in upper third of leaf; rhizoidal tubers red, crimson to red-brown...9

9 Leaves narrowly ovate and acuminate, somewhat keeled near apex; margin mostly entire; upper laminal cells elongate and sublinear (4–6: 1); tubers red to orange *(8:)* .... **7. R. leptothrix**

9: Leaves acute, ovate to obovate; upper margin usually serrulate to serrate; upper laminal cells short and broad (2–4: 1); tubers red, crimson or brown 10

10 Dioicous; tubers dark brown or red-brown, concolorous with rhizoids; leaves usually distinctly spirally twisted; capsules mostly brownish, generally horizontal or suberect; endostome segments gradually acuminate into a projection *(9:)*...**4. R. capillare**

10: Polyoicous; tubers bright red or crimson; leaves contorted but rarely spirally twisted; capsules often bright red, nutant; endostome segments rounded and abruptly apiculate .... **12. R. torquescens**

11 Leaves appressed to stem, imbricate, not much contorted when dry, concave; upper and middle laminal cells walls firm to distinctly incrassate *(6:)*...12

11: Leaves variously contorted when dry, not imbricate, usually not concave; upper and middle laminal cells thin to firm-walled, rarely incrassate 14

12 Upper leaf margin with an very broad border (> 4 layers of cells), finely crenulate; rhizoidal tubers present *(11)*...**[R. perlimbatum]**

12: Upper leaf margin with a narrow border, or border ±absent, distinctly serrate; rhizoidal tubers absent 13

13 Plants golden or brown-green; hairpoint long, straight, golden-brown *(12:)*.........**3. R. campylothecium**

13: Plants red-green; hairpoint very short as a recurved mucro....................................... **8. R. microrhodon**

14 Stems distinctly rosulate, short; lower leaves smaller than upper leaves *(11:)* 15

14: Stems elongate, not distinctly rosulate, with equidistant leaves occasionally crowded and enlarged at the apex 16

15 Upper leaf border > 4 cells wide, strong, often hyaline; leaves mostly elongate-spathulate; setae usually hooked at capsule base (in > 80% of sporophytes) *(14)* .... **11. R. subtomentosum**

15: Upper leaf border 1–3 cells wide, not hyaline, often indistinct; leaves mostly obovate; setae rarely hooked at base of capsule (< 20%) .... **2. R. billarderi**

16 Leaves strongly keeled (when moist or dry), elongate, ovate-lanceolate to spathulate (*14:)* .... **10. R. subfasciculatum**

16: Leaves flat, broadly ovate to spathulate.. 17

17 Upper leaf border 4 or more cells wide, often hyaline; leaves elongate-spathulate; gametangia not conspicuously enlarged; old leaves and stems often blackish; capsule mouth straight; tubers present *(16:)* .... **11. R. subtomentosum**

17: Upper leaf border 1 or 2 cells wide, often indistinct, never hyaline; leaves mostly ovate; gametangia conspicuously enlarged; plants remaining green or brownish green; capsule mouth oblique; tubers absent .... **14. R. wightii**

1. Rosulabryum albolimbatum (Hampe) J.R.Spence, *Bryologist* 99: 223 (1996)

Rhodobryum albolimbatum Hampe, *Linnaea* 36: 517 (1870); *Bryum albolimbatum* (Hampe) A.Jaeger, *Ber. Tätigk. St. Gallischen Naturwiss. Ges*. 1873–74: 191 (1875). T: Porongorups, W.A., Oct. 1867, *F.Mueller*; holo: BM.

Bryum pusillum Broth., *Oefvers Förh. Finska Vetensk.-Soc*. 33: 11, 12 (1890), *nom. illeg.* (later homonym); *Rhodobryum pusillum* Paris, *Index. Bryol.* 1119 (1898). T: Helidon, Qld, Dec. 1888, *C.Wild* 9; holo: H-BR; iso: BRI.

Illustrations: H.Ochi, *J. Fac. Educ. Tottori Univ. Nat. Sci*. 21: 49, fig. 30H–J (1970), as *B. capillare*; H.Syed, *Bryologist* 77: 305, fig. 21; 306, fig. 22 (1973), as *B. albolimbatum*; D.G.Catcheside, *Mosses of South Australia* 261, fig. 151 (1980), as *B. albolimbatum*.

Dioicous. Plants in loose tufts, 5–15 mm tall, deep green to reddish green. Rhizoids brown, finely papillose. Leaves soft, obovate-spathulate or ovate, 1.5–3.5 mm long, clustered in rosettes, reduced below, flat, little-altered when dry, slightly twisted; margin coarsely serrate at least in the uppermost 25–35% of the leaf; costa brown, excurrent; border of 3 or 4 rows of narrow elongate cells; upper laminal cells rhomboidal to hexagonal, short and narrow, 30–60 × 12–20 µm, thin-walled, rarely porose; basal cells rectangular, 40–100 × 15–22 µm, porose. Gemmae as globose or oval orange tubers, 250–400 µm across; superficial cells not protruding; filamentous gemmae in leaf axils, pale brown, papillose, 15–35 µm long. Perichaetial leaves narrow, lanceolate; margin coarsely dentate; costa excurrent. Setae 10–20 mm long, straight. Capsules nodding to inclined, subcylindrical, 2–4 mm long. Spores 12–16 µm diam. Chromosome number not known. Fig. 46A–I.

A widespread, endemic species in W.A., S.A., Qld, N.S.W. and Vic.; grows on soil or, more commonly, on wood or rock in moist, often shaded habitats. Map 193.

W.A.: Two Peoples Bay Nature Reserve, *J.R.Spence 4180* (NSW). S.A.: Hindmarsh Valley, *D.G.Catcheside 53.283* (AD). Qld: Nandroya Falls, Palmerston North Natl Park, *I.G.Stone 24847* (MEL); Bunya Mtns, *F.M.Bailey 184, 187* (BRI). N.S.W.: Rous, Richmond R., *W.W.Watts 1312* (NSW).

Although placed into synonymy with *R. capillare* by Ochi (1970), *R. albolimbatum* was recognised as a distinct species by Syed (1973). It can be distinguished by the rosulate stems, coarsely serrate leaves near the apex which are shrunken and contorted but not spirally twisted when dry, and by the presence of filamentous gemmae in the leaf axils. It appears to be related to South American and South African species such as *R. andicola* (Hook.) Ochyra.

2. Rosulabryum billarderi (Schwägr.) J.R.Spence, *Bryologist* 99: 223 (1996)

Bryum billarderi Schwägr., *Sp. Musc. Frond.*, Suppl. 1, 2: 115 (1816). T: Tas., locality unknown, *J.-J.H. de Labillardière*, *fide* Ochi (1970); *n.v.*, type lost, *fide* Mohamed (1979).

Bryum leptothecium Taylor, *Phytologist* 1: 1094 (1844); *Rhodobryum leptothecium* (Taylor) Paris, *Index Bryol*. 1117 (1898). T: locality unknown; *n.v.*

Bryum robustum Hampe, *Linnaea* 28: 205 (1856); *Rhodobryum robustum* (Hampe) Paris, *Index Bryol.* 1120 (1898). T: “Australia felix”, *F.Mueller*; holo: BM; iso: MEL.

Bryum rufescens Hook.f. & Wilson, *in* J.D.Hooker, *Fl. Tasman*. 2: 192 (1859), *nom. illeg.* (later homonym). T: Hobarton [Hobart], Tas., *R.C.Gunn 1691*; syn: BM; near Risdon, Tas., *J.D.Hooker*; syn: *n.v*.

Bryum rufescens Hook.f. & Wilson var. *brevifolium* Wilson, *in* J.D.Hooker, *Fl. Tasman*. 2: 192 (1859). T: by the seaside, Point Esperance, Penquite, Tas., *R.C.Gunn 1556*; syn: *n.v.*; *A.F.Oldfield 334*; syn: BM.

Bryum rufescens Hook.f. & Wilson var. *mamillatum* Wilson, *in* J.D.Hooker, *Fl. Tasman*. 2: 192 (1859). T: St. Patrick's River, Tas., *R.C.Gunn 1585*; holo*:* BM.

Rhodobryum breviramulosum Hampe, *Linnaea* 40: 311 (1876); *Bryum breviramulosum* (Hampe) Hampe, *Fragm.* 11 (Suppl.): 48 (1881). T: locality unknown; *n.v*.

Bryum viridulum Müll.Hal., *Hedwigia* 37: 104 (1898); *Rhodobryum viridulum* Paris, *Index Bryol*., Suppl. 1: 301 (1900). T: Mt Dromedary, N.S.W., 1883, *Miss Bate*; syn: MEL; Sydney, N.S.W., 1881, *Rev. Dr Wools*; syn: MEL; Domina, N.S.W., *D.Kayser* [Herb. Geheeb 1876]; syn: *n.v.*

Bryum brachyaris Müll.Hal., *Trans. & Proc. Roy. Soc. Victoria* 19: 73 (1882). T: source of Yarra, Cardies R., Vic., Oct. 1873, *F.Mueller*; syn*: n.v.*; Apollo Bay, Vic., *F.Mueller 55*; syn: NSW.

Bryum aeruginosum Müll.Hal., *Hedwigia* 37: 95 (1898). T: Balls Head Bay, Sydney, N.S.W., Oct. 1884, *T.Whitelegge*; syn: MEL; isosyn: NSW; Double Bay, [Sydney, N.S.W.], July 1884, *T.Whitelegge*; syn: NSW.

Bryum abruptinervium Müll.Hal., *Hedwigia* 37: 102 (1898); *Rhodobryum abruptinervium* (Müll.Hal.) Paris, *Index Bryol.*, Suppl. 1: 298 (1900). T: Dimboola, Vic., July 1883, *F.M.Reader*; syn: MEL; Murrumbeena, Vic., Aug. 1886, *F.M.Reader*; syn: MEL; isosyn: BM?, H-BR, NSW.

Bryum brunneidens Müll.Hal., *Hedwigia* 37: 105 (1898); *Rhodobryum brunneidens* (Müll.Hal.) Paris, *Index Bryol*., Suppl. 1: 299 (1900). T: Genoa R., East Gippsland, Vic., 1881, *Witherhead*; holo: MEL *n.v.*

Bryum dobsonianum Müll.Hal., *Hedwigia* 37: 108 (1898); *Rhodobryum dobsonianum* (Müll.Hal.) Paris, *Index Bryol.*, Suppl. 1: 299 (1900). T: Dead Is., Tas., 1884, *Judge Dobson*; holo: MEL *n.v.*

Bryum ischyrrhodon Müll.Hal., *Hedwigia* 37: 103 (1898). T: Clarence R., N.S.W., Nov. 1875, *Wilcox*; holo: MEL; iso: H-BR.

Bryum pohliaeopsis Müll.Hal., *Hedwigia* 37: 107 (1898). T: Moyston, Vic., Oct. 1883, *D.Sullivan*; holo: S; iso: MEL, NSW.

Rhodobryum tasmanicum Paris, *Index Bryol*., Suppl. 1: 301 (1900), *nom. illeg. incl. spec. prior.*; *n.v.*

Bryum globulare Hampe ex Müll.Hal., *Genera Musc. Frond*. 238 (1900). T: Novae Hollandiae, *coll. unknown*; holo: B.

Bryum crenatidens Müll.Hal., *Genera Musc. Frond*. 238 (1901), *nom. nud.* (in synon.). Based on: Cambewarra, N.S.W., Nov. 1885, *T.Whitelegge 332*; Cambewarra, N.S.W., Dec. 1885, *T.Whitelegge* (NSW).

Bryum madoriculum Müll.Hal., *in* W.W.Watts & T.Whitelegge, *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 143 (1906), *nom. nud.* (in synon.). Based on: Dimboola, Vic., 10 Sept. 1897, *F.M.Reader* (MEL).

Bryum forsythii Broth., *Proc. Linn. Soc. New South Wales* 41: 592 (1916). T: Kiama, N.S.W., *W.Forsyth 384*; syn: H-BR; isosyn: NSW; *loc. id.*, *W.Forsyth 390*; syn: NSW.

Illustrations: H.Ochi, *J. Fac. Educ. Tottori Univ. Nat. Sci*. 21: 54, fig. 34; 56, fig. 35 (1970), as *Bryum robustum*; G.A.M.Scott & I.G.Stone, *The Mosses of Southern Australia* 279, pl. 51 (1976), as *Bryum billardierei*; R.D.Seppelt, *The Moss Flora of Macquarie Island* 113, fig. 44 (2004).

Dioicous. Plants in loose or dense tufts, green or yellow-green, 1–6 cm tall, simple or repeatedly branched, with a brown tomentum below. Rhizoids brown to reddish brown, densely papillose. Leaves distinctly rosulate with smaller leaves below, ovate or oblong to obovate, ±contorted when dry, imbricate, not spirally arranged around the stem, 1.5–5.0 (–6.0) mm long, 1.0–1.8 (–2.5) mm wide, widest 67–80% from base; margin distinctly toothed above, strongly recurved in lower three-quarters; border narrow, 1–3 cells wide, not hyaline; costa strong, excurrent, colourless above; upper laminal cells rhomboidal-hexagonal, 40–81 × 12–23 µm; basal cells ±broadly rectangular. Gemmae as rhizoidal tubers, scattered, sometimes abundant, produced on short rhizoids, orange to red, globose or oval, (300–) 500–1000 µm in widest axis, 10–25 cells across face; cells not projecting. Setae 20–30 mm long, straight; perichaetia often polysetose. Capsules oval to cylindrical or oblong-cylindrical, with a distinct neck, horizontal to cernuous when dry, 3–6 mm long. Spores 15–20 µm diam. n = 10, *fide* H.P.Ramsay & J.R.Spence, *J. Hattori Bot. Lab*. 80: 261 (1996). Fig. 46J–S, Plate 44.

Widely distributed in all States and Territories except N.T.; grows on soil, wood or on soil over rock; common, especially in shaded habitats. A circum-temperate to subtropical species of the Southern Hemisphere, in Africa, Australasia, Malesia, Oceania, New Zealand and Macquarie Is. Map 194.

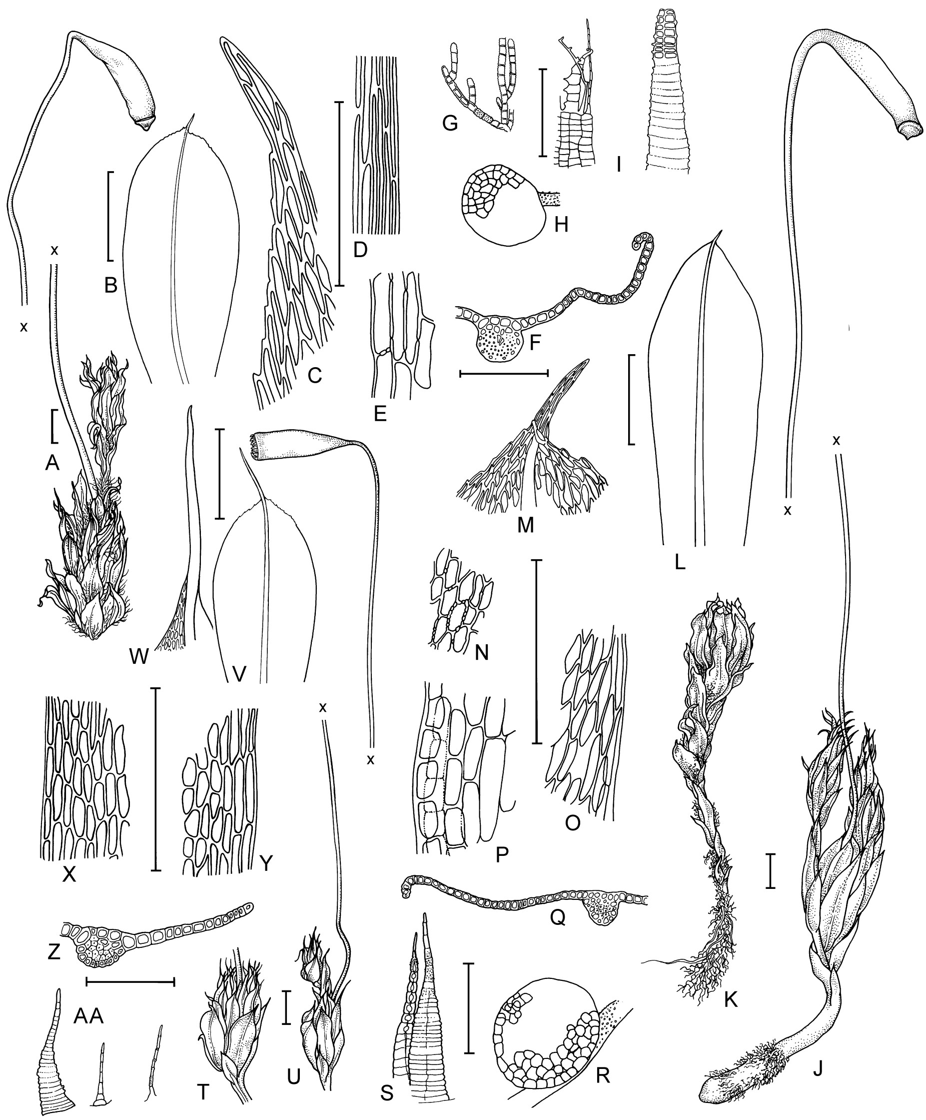

Figure 46. *Rosulabryum*. **A–I**, *R. albolimbatum*. **A**, Habit of dry specimen with sporophyte; **B**, Leaf; **C**, Cells at leaf apex; **D**, Mid-leaf and marginal cells; **E**, Basal laminal cells (A–E, *D.G.Catcheside 53.283*, AD); **F**, Part of T.S. of leaf (*D.G.Catcheside 53.079*, AD); **G**, Filamentous gemmae (*W.W.Watts 3463*, NSW); **H**, Rhizoidal tuber (*P.S. & D.E.A.Catcheside J17*, AD); **I**, Peristome: endostome basal membrane with segment and cilia (left); exostome tooth (right) (*D.G.Catcheside 53.283*, AD). **J–S**, *R. billarderi*. **J**, Habit of dry specimen with sporophyte (*L.D.Williams 3874*, AD); **K**, Male gametophyte (*D.G.Catcheside 69.266*, AD); **L**, Leaf; **M**; Leaf apex; **N**, Upper laminal cells; **O**, Margin at mid-leaf; **P**, Basal laminal cells (L–P, *C.T.Clifford s.n.*, MEL); **Q**, T.S. of leaf; **R**, Rhizoidal tuber (Q, R, *D.G.Catcheside 69.266*, AD); **S**, Peristome (*D.G.Catcheside 69.266*, AD). **T–AA**, *R. campylothecium*. **T**, Male gametophyte; **U**, Female habit with sporophyte; **V**, Leaf; **W**, Leaf apex; **X**, Mid-leaf and marginal cells; **Y**, Basal laminal cells; **Z**, T.S. of leaf; **AA**, Peristome: exostome tooth (left); endostome segment (centre); and cilium (right) (T–AA, *W.A.Weymouth s.n.*, NSW). Scale bars: 1 mm for habit; 0.5 mm for leaves, 100 µm for cellular drawings. Drawn by L.Elkan.

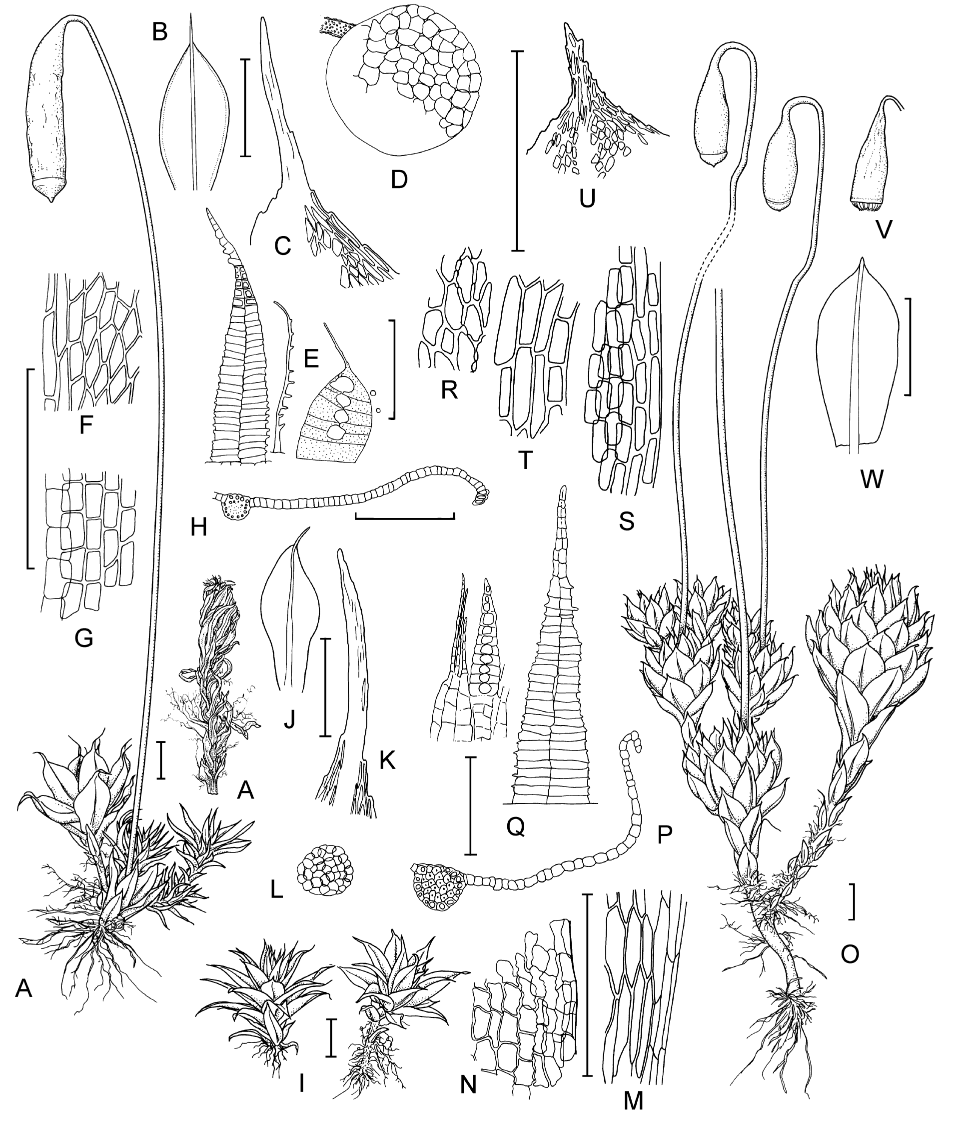

Figure 47. *Rosulabryum*. **A–H**, *R. capillare*. **A**, Left: habit with sporophyte (moist specimen); right: leaves spirally arranged (dry specimen); **B**, Leaf; **C**, Cells at leaf apex; **D**, Rhizoidal tuber; **E**, Peristome: exostome tooth (left); endostome cilium (centre) and segment (right); **F**, Mid-leaf cells; **G**, Basal laminal cells; **H**, T.S. of leaf (A–H, *J.R.Spence 4364*, NSW). **I–N**, *R. leptothrix*. **I**, Habit (dry specimen); **J**, Leaf; **K**, Cells of leaf apex; **L**, Rhizoidal tuber; **M**, Mid-leaf cells; **N**, Basal laminal cells (I–N, *I.G.Stone 22764*, MEL). **O–W**, *R. microrhodon*. **O**, Habit with sporophyte (dry specimen); **P**, T.S. of leaf; **Q**, Peristome: endostome (left); exostome (right); **R**, Upper laminal cells; **S**, Mid-leaf cells and margin; **T**, Basal laminal cells; **U**, Leaf apex; **V**, Capsule with peristome; **W**, Leaf (O–W, *J.R.Spence 4585*, NSW). Scale bars: 1 mm for habit; 0.5 mm for leaves, 100 µm for cellular drawings. Drawn by L.Elkan.

W.A.: Porongurup Natl Park, 27 km N of Albany, *D.H.Norris 26286* (BRI). S.A.: Eyre Penin., *L.D.Williams 3657a* (AD). Qld: Caboolture, *C.J.Wild s.n.* (BRI). N.S.W.: Yarrangobilly Caves, *W.W.Watts 8744* (NSW). A.C.T.: Black Mtn, *J.Sawyer 35* (BRI). Vic.: near Bogong, *D.G.Catcheside 69.266* (AD). Tas.: Mt Barrow, *M.Tindale s.n.* (NSW).

Rosulabryum billarderi is closely related to *R. subtomentosum* from which it differs in the mostly obovate leaves with a narrow border and setae only very rarely hooked at the base of the capsules. By contrast, the leaves of *R. subtomentosum* are spathulate, with a broad, often hyaline border 4 or more cells wide and setae mostly hooked at the base of the capsules. This species differs from *R. subfasciculatum* which has more elongate stems and equidistant leaves that are crowded near the apex, but not distinctly rosulate.

This complex and variable species has many synonyms and it has been variously interpreted; Ochi (1970) took a broad view, unlike Mohamed (1979). We have adopted the latter approach, as combining the many unrelated species recognised from around the world by Ochi cannot be supported. More work is required on the group in Australia, especially the apparently distinct forms occurring in the mountains of north-eastern N.S.W. and south-eastern Qld.

3. **Rosulabryum campylothecium** (Taylor) J.R.Spence, *Bryologist* 99: 223 (1996)

Bryum campylothecium Taylor, *London J. Bot*. 5: 52 (1846); *Rhodobryum campylothecium* (Taylor) Paris, *Index Bryol*. 1115 (1897). T: Swan R., W.A., 1843, *J.Drummond*; holo: BM; iso: H. [Specimens at NSW, labelled "*sp. nov*. Perth" by Brotherus are possible isotypes.]

Bryum chlororhodon Müll.Hal., *Hedwigia* 37: 107 (1898). T: Dimboola, Vic., July 1896, *F.M.Reader s.n.*; lecto: MEL, *fide* J.R.Spence & H.P.Ramsay, *Fl. Australia* 51: 412 (2006); isolecto: MEL; Dimboola, Vic., July 1896, *F.M.Reader 16*; syn: NSW.

Bryum pεraristatum Müll.Hal., *Hedwigia* 37: 106 (1898), *nom. illeg.* (later homonym); *Rhodobryum peraristatum* (Müll.Hal.) Paris, *Index Bryol.*, Suppl. 1: 300 (1900). T: Clarendon, Vic., *O.Tepper*; holo: MEL *n.v.*

Bryum pallenticoma Müll.Hal., *Hedwigia* 37: 100 (1898); *Rhodobryum pallenticoma* (Müll.Hal.) Paris, *Index Bryol*., Suppl. 1: 300 (1900). T: Swan R., W.A., *L.Preiss*; *n.v.*

Bryum billarderi Schwägr. var. *cygnicollum* Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 128 (1906), *nom. nud.* (in synon.). Based on: Mt Lofty Ra., S.A., 1850, *F.Mueller s.n.* (MEL).

Illustrations: H.Ochi, *J. Fac. Educ. Tottori Univ. Nat. Sci*. 21: 51, fig. 32A–D (1970); D.G.Catcheside, *Mosses of South Australia* 264, fig. 153 (1980), both as *Bryum campylothecium.*

Dioicous. Plants loosely to densely tufted, usually 10–20 mm tall, yellowish green to bronze above, darker below. Stems stout, tomentose below. Rhizoids sparse, red-brown, coarsely papillose. Leaves ±comose, 2–3 mm long, closely imbricate in dense comal tufts, rather stiff and thick, spreading or patent when moist, scarcely altered when dry, tufted at shoot apices, broadly obovate, strongly concave; apex acute; marginal cells projecting as small blunt teeth in upper part, entire below, recurved for lower three-quarters of leaf, with a weak border of 2–4 longer narrower incrassate cells; costa excurrent in a long straight smooth or denticulate hairpoint, golden-brown; upper laminal cells rhomboidal-hexagonal, 35–45 × 18–20 µm; walls incrassate; basal cells rectangular. Gemmae not known. Setae 15–25 mm long, straight. Capsules horizontal or cernuous, clavate or oblong-pyriform, 1.5–2.5 mm long. Spores 16–20 µm diam. Chromosome number not known. Fig. 46T–AA, Plate 41.

Occurs in W.A., S.A., N.S.W., A.C.T., Vic. and Tas.; grows on sandy soil in the open, especially in sand dunes and in mallee. Also in New Zealand and South America. Map 195.

W.A.: Hampton Ra., 20 km E of Mundrabilla HS, Oct. 1979, *D.E.A.Catcheside* (AD). S.A.: Kangaroo Is., *E.M.Martin 9.4* (AD). N.S.W.: The Gap, near Young, *W.W.Watts 7723* (NSW). A.C.T.: Tidbinbilla, *H.Streimann 70* (CANB). Vic.: Grampians Natl Park, *I.G.Stone 2596* (MEL). Tas.: Kangaroo Pt, *W.A.Weymouth 500* (NSW).

The species is characterised by the absence of tubers, leaves that are ovate, concave and imbricate, with a long hairpoint and a golden or yellow-green colour. It is closely related to *R. microrhodon* from Tasmania, but it differs in coloration, habitat, and the long hairpoint. Capsules are rare.

4. Rosulabryum capillare (Hedw.) J.R.Spence, *Bryologist* 99: 223 (1996)

Bryum capillare Hedw., *Sp. Musc. Frond.* 182 (1801). T: Europe; *n.v.*

Bryum immarginatum Broth., *Oefvers. Förh. Finska Vetensk.-Soc.* 35: 50 (1893). T: Mt Perry, Qld, *J.Keys s.n.*; syn: H-BR; *loc. id.*, *F.M.Bailey 239*; syn: H-BR.

Bryum plebejum Müll.Hal., *Hedwigia* 37: 94 (1898). T: Port Phillip, Vic., 1883, *French*; holo: MEL *n.v.*

Bryum luehmannianum Müll.Hal., *Hedwigia* 37: 100 (1898); *Rhodobryum luehmannianum* (Müll.Hal.) Paris, *Index Bryol.*, Suppl. 1: 300 (1900). T: Upper Yarra R., Fernshaw, Vic., Jan. 1881, *Luehmann s.n.*; holo: MEL.

Bryum microsporum Broth., *Oefvers. Förh. Finska Vetensk.-Soc.* 42: 116 (1899), *nom. illeg.* (later homonym). T: Masons Ck, Peppermint Bay, Tas., *W.A.Weymouth 1848*; holo: H-BR.

Bryum flaccidifolium Müll.Hal., *Genera Musc. Frond.* 238 (1901), *nom. nud.* (in synon.). Based on: Rose Bay, N.S.W., 26 Aug. 1899, *W.Forsyth 390*; Lane Cove, N.S.W., 3 May 1899, *W.Forsyth 39* (BM, NSW).

Bryum flaccidisetum Hampe ex Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 143 (1906), *nom. nud.* (in synon.). Based on: hilly mallee country, NW of Dimboola, Wimmera, Vic., 26 June 1896, *F.M.Reader s.n.* (MEL, NSW).

Bryum erythropyxis Müll.Hal. var. *minus* Broth. ex Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 132 (1906). T: Newrybar, Brooklet and Pearces Ck, Richmond R., N.S.W., 1899, *W.W.Watts s.n.*; syn: NSW.

Bryum nanoides Müll.Hal. ex Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 143 (1906), *nom. nud.* (in synon.). Based on: Dimboola, Vic., 22 July 1897, *F.M.Reader s.n.* (MEL).

Bryum nanotorquescens Müll.Hal. ex Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 143 (1906), *nud. nud.* (in synon.). Based on: Dimboola, Vic., 26 July 1897, *F.M.Reader s.n.* (MEL).

Bryum sublonginervium Geh., *in* W.W.Watts & T.Whitelegge, *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 143 (1906), *nom. nud.* (in synon.). Based on: Cambewarra, N.S.W., 29 Sept. 1885, *C.Harris 295* (NSW).

Illustrations: H.Ochi, *J. Fac. Educ. Tottori Univ. Nat. Sci.* 21: 48, figs 30, 31 (1970), as *B. capillare*; A.Eddy, *Handb. Malesian Mosses* 3: 129, fig. 415 (1996), as *B. capillare*; H.Streimann, *The Mosses of Norfolk Island* 28, fig. 9 (2002).

Dioicous. Plants in loose or dense tufts, 10–25 mm tall, usually dark green, scarcely glossy, soft, matted with brown to reddish brown papillose rhizoids below. Leaves shrunken, spirally twisted around stem and with flexuose apices when dry, erect-spreading when moist, variable in size, to 3 mm long, obovate-spathulate, plane or concave, short-acuminate, abruptly aristate from the costa; margin entire below, usually finely serrulate to, occasionally, serrate above, recurved to about half-way or more; costa percurrent to short-excurrent; hairpoint filiform, concolorous with costa, straight or bent; upper laminal cells hexagonal or rhomboidal-hexagonal, 35–50 × 15–25 µm, thin-walled; cells longer and narrower and in 2–4 rows at margin, usually with hyaline walls; basal cells long-rectangular. Gemmae as rhizoidal tubers, reddish brown, globose or ovoid, 60–250 µm wide, the outer cell walls not projecting. Setae 20–30 mm long, reddish, sometimes curved above. Capsules cernuous, horizontal to pendent, cylindrical to pyriform, 1.5–3.0 mm long, pale brown to brown. Exostome teeth oblong-lanceolate, yellow with a hyaline border. Spores 8–12 µm diam. $n = 20$, *fide* H.P.Ramsay, *Austral. J. Bot.* 22: 311 (1974), as *Bryum billarderi*. Fig. 47A–H.

Occurs in all States and Territories; grows on soil and sand or on shaded rocks and trees. Also in northern Europe, Africa, North, Central and northern South America, East Asia, Lord Howe Is., Norfolk Is. and New Zealand. Map 196.

W.A.: Margaret R., *A.C.Beauglehole 14378* (MEL). N.T.: Mt Giles, *P.K.Latz 6614b p.p.* (AD). S.A.: Port Gemein, *I.G.Stone 6049* (MEL). Qld: Malanda, *H.Streimann 16854* (CANB). N.S.W.: Jenolan Caves, *A.J.Downing 5810* (NSW). A.C.T.: Australian Natl Botanic Gardens, Canberra, *H.Streimann 48999* (CANB). Vic.: Aireys Inlet, *R.D.Seppelt 3960* (MEL). Tas.: St. Patricks Head, *W.A.Weymouth 2652* (CANB).

Rosulabryum capillare and *R. torquescens* are somewhat similar, but they can be distinguished by the colour of the rhizoids, rhizoidal gemmae and leaves. Plants of *R. capillare* are dioicous, rhizoidal gemmae are brown to red-brown with concolorous rhizoids, and the leaves tend to be spirally twisted around the stem. By contrast, *R. torquescens* is synoicous (rarely autoicous or dioicous), rhizoidal gemmae are crimson or orange with brown-red rhizoids, and the leaves are contorted but rarely spirally twisted.

Filamentous gemmae have been reported occasionally for *R. capillare*.

5. Rosulabryum epiphyticum J.R.Spence & H.P.Ramsay, *Telopea* 8: 325 (1999)

T: Port Macquarie, N.S.W., 8 Aug. 1991, *A.J.Downing s.n.*; holo: BRI; iso: NSW.

Illustration: J.R.Spence & H.P.Ramsay, *op. cit.* 327, fig. 1.

Dioicous. Plants loosely tufted, to 5 mm tall, green, becoming golden-brown with age. Stems sparingly branched by subfloral innovations, sparsely tomentose, with equidistant leaves. Rhizoids pale brown to orange-brown, coarsely papillose. Leaves ovate to obovate, contorted when dry, erect-spreading when moist, 1–2 mm long, bright green, becoming golden with age; margin entire to slightly serrulate in upper part, plane; border lacking or weak and with a single layer of narrow elongate thick-walled cells; costa percurrent to short-excurrent as a stout point to 150 µm long, brown, often somewhat toothed; upper and mid-laminal cells rhomboidal, 35–90 × 10–20 µm (3–4: 1), becoming longer (to 100 µm) and regularly rectangular below; innovation leaves similar but somewhat smaller. Gemmae mostly unbranched, filiform, in axils of upper leaves on sterile stems, brownish, coarsely papillose; rhizoidal tubers red-brown, occasional on long rhizoids in substratum, globose, 200–250 µm wide; cells 12–25 µm across, the walls not projecting. Setae 20–25 mm long. Capsules inclined to nutant, narrowly clavate to cylindrical, 2–3 mm long, brown; mouth broad. Spores smooth, 12–15 µm diam. n = 11, *fide* H.P.Ramsay & J.R.Spence, *J. Hattori Bot. Lab.* 80: 262 (1996), as "*Rosulabryum* nov. sp.". Fig. 48A–J.

A rare, endemic species in the coastal ranges of eastern Qld and north-eastern N.S.W.; usually on the twigs of trees and shrubs and on orchid roots; sometimes on rocks in rainforest. Map 197.

Qld: Downey Ck, Innisfail, *I.G.Stone 24701* (MEL); Riflebird Ck, Binna Burra, *I.G.Stone 12919* (MEL); Expedition Ra., *I.G.Stone 121181* (MEL); Mt Haig, *I.G.Stone 22260* (MEL); Stairway Falls, Lamington Natl Park, *I.G.Stone 11998* (MEL).

Rosulabryum epiphyticum is a distinctive species in a habitat that is unique for the genus. The stems with ovate equidistant leaves, the percurrent or very short-excurrent costae and filiform gemmae in the leaf axils are diagnostic.

6. Rosulabryum lamingtonicum J.R.Spence & H.P.Ramsay, *Telopea* 8: 328 (1999)

T: Cedar Creek Natl Park, Tambourine Mtn, Qld, *A.Mertens 3*; holo: BRI; iso: NSW.

Illustration: J.R.Spence & H.P.Ramsay, *op. cit.* 331, fig. 3.

Dioicous. Plants small, tufted; young shoots bright green, darkening with age. Stems 5–10 mm tall, sparingly rhizomatous, unbranched or sparingly branched by subfloral innovations, with dimorphic leaves. Rhizoids reddish brown, finely papillose. Rosette leaves dark olive-green with red tints, ovate to spathulate, contorted when dry or often spreading and flattened, spreading when moist, strongly keeled, not decurrent, 2–3 mm long; margin serrate, with large colourless teeth confined to upper half of lamina; border weak or absent below; costa strong at base, narrowing above and not reaching apex to percurrent, colourless above, reddish below, often with a small apiculus; upper and middle laminal cells irregularly rhomboidal, 45–75 × 12–20 µm (2–3: 1), becoming longer and more rectangular below. Sterile innovation leaves equidistant, not rosulate, broadly ovate to obovate, 1–2 mm long, bright green, decurrent; margin strongly serrate, with hyaline teeth often reaching the leaf base, teeth often at right angles to border; costa not reaching leaf apex, colourless; laminal cells as in rosette leaves. Gemmae filamentous, in small clumps, with ±smooth walls, short, mostly unbranched; rhizoidal tubers red-brown, highly variable, irregularly globose, 100–500 µm wide. Inner perigonial leaves smaller than outer leaves, broadly ovate, apiculate; perichaetial leaves narrower. Setae long-exserted, 18–20 mm long. Capsules clavate to pyriform, somewhat inclined, 1.0–2.5 mm long, brown. Spores 15–25 µm diam. Chromosome number not known. Fig. 48S–AA.

An endemic, mainly corticolous species in eastern Qld and north-eastern N.S.W. Map 198.

Qld: track to Mt Hobwee, Lamington Natl Park, *J.R.Spence 5192* (NSW); W side of Mt Hobwee, *J.R.Spence 5191a* (NSW); near turnoff to Millaa Millaa Falls, *H.P.Ramsay R225* (NSW); Hugh Nelson Ra., *H.Streimann 57742* (CANB). N.S.W.: Whian Whian State Forest, *I.G.Stone 1391* (MEL).

The broadly ovate to spathulate, keeled and strongly serrate leaves are very similar to those of *R. subfasciculatum*, but the serrations are more distinct and extend to mid-leaf in *R. lamingtonicum*. Moreover, the rhizoidal gemmae are red to orange-red in *R. subfasciculatum* but brownish in *R. lamingtonicum*. The small size and the rosulate, fertile stems suggest an affinity with *R. capillare* or *R. leptothrix*, while the filamentous gemmae are similar to those of *R. albolimbatum* and *R. epiphyticum*.

7. **Rosulabryum leptothrix** (Müll.Hal.) J.R.Spence, *Bryologist* 99: 223 (1996)

Bryum leptothrix Müll.Hal., *Hedwigia* 37: 94 (1898). T: Trinity Bay, [Cairns], Qld, *Karsten*; holo: MEL? [not located]; iso: H-BR.

Illustration: H.Ochi, *J. Fac. Educ. Tottori Univ. Nat. Sci*. 21: 47, fig. 29 (1970), as *Bryum leptothrix*.

Dioicous. Plants small, green. Stems 10–20 mm long, solitary or in open tufts, sparsely branched. Rhizoids sparse, pale brown to red-brown, papillose. Leaves spirally twisted around stem when dry, erect-spreading when moist, narrowly obovate to ovate, acuminate, 1–3 mm long; margin finely serrulate near apex; border weak; costa slender, excurrent; upper laminal cells elongate, sublinear, mostly < 80 µm long (4–6: 1); lower cells more regularly rectangular. Gemmae as rhizoidal tubers, 100–200 µm wide, globose, red to orange; cell walls not projecting. Capsules not seen. Chromosome number not known. Fig. 47I–N.

An endemic species in Qld, N.S.W. and Vic.; grows on soil or soil-covered rock ledges in seasonally arid regions. Map 199.

Qld: Mungana, *W.L.Leafe* [*I.G.Stone 16742*] (MEL); Crediton State Forest, 16 km SW of Finch Hatton, *H.Streimann 37684* (CANB). N.S.W.: Gloucester R., *H.Streimann 6469* (CANB); Nightcap Natl Park, *I.G.Stone 25976*, *25977* (MEL). Vic.: Chimney Pot picnic area, Grampians Natl Park, *J.R.Spence 4370* (NSW).

Rosulabryum leptothrix is characterised by its narrow, small to medium-sized leaves that are spirally twisted around the stem when dry, elongate upper and middle laminal cells and a weak, predominantly entire border. It is probably closest to the subcosmopolitan *R. capillare*.

8. **Rosulabryum microrhodon** (Müll.Hal.) J.R.Spence, *Bryologist* 99: 223 (1996)

Bryum microrhodon Müll.Hal., *Hedwigia* 37: 108 (1898); *Rhodobryum microrhodon* Paris, *Index Bryol*. 1118 (1898), *nom. nud*. T: St. Crispins Ck, Mt Wellington, Tas., 1890, *W.A.Weymouth 522*, *523*; syn: CANB (*Weymouth 522*), HO; Kangaroo Pt, Tas., 1890, *W.A.Weymouth*; syn: H, S *n.v*.

Illustrations: M.A.Haji Mohamed, *Bryologist* 10: 448, fig. 24 (1979), as *Bryum microrhodon*; H.Ochi, *J. Fac. Educ. Tottori Univ. Nat. Sci*. 21: 57, fig. 36a–e (1970), as *Bryum billardieri p.p*.

Dioicous. Plants densely to loosely tufted, 5–20 mm tall, green above, reddish below; lower part of stem sometimes lacking leaves or with loose reddish tomentum. Rhizoids reddish brown to reddish purple, coarsely papillose. Leaves small, imbricate, sometimes in a small compact coma, mostly concave, carinate, 2.5–3.5 mm long, obovate, widest 50–67% from the base, not contorted when dry, green tinged with red at base; margin serrate; border narrow, of 1–3 cell layers, ±absent above; costa short-excurrent in a recurved arista, golden-green to red-green; upper laminal cells short-hexagonal or rhomboidal, 16–25 × 25–45 µm (2–3: 1); walls firm to distinctly incrassate. Gemmae absent. Perichaetial leaves tinged with red, lanceolate, cuspidate; margin plane to crenulate above, recurved below; costa long-excurrent in an arista. Setae 14–29 mm long. Capsules oblong to clavate, horizontal to cernuous when dry, cernuous to pendulous when moist, 2.3–4.0 mm long; mouth large; neck narrow. Spores 11–13 µm diam. Chromosome number not known. Fig. 47O–W.

Occurs in subalpine Tas., mainly on soil and rock, sometimes on wood. Also in the South Island of New Zealand. Map 200.

Tas.: Falls Track area, Hartz Mtns, *J.R.Spence 4585* (NSW); Ben Lomond Natl Park, *J.R.Spence 4672* (NSW).

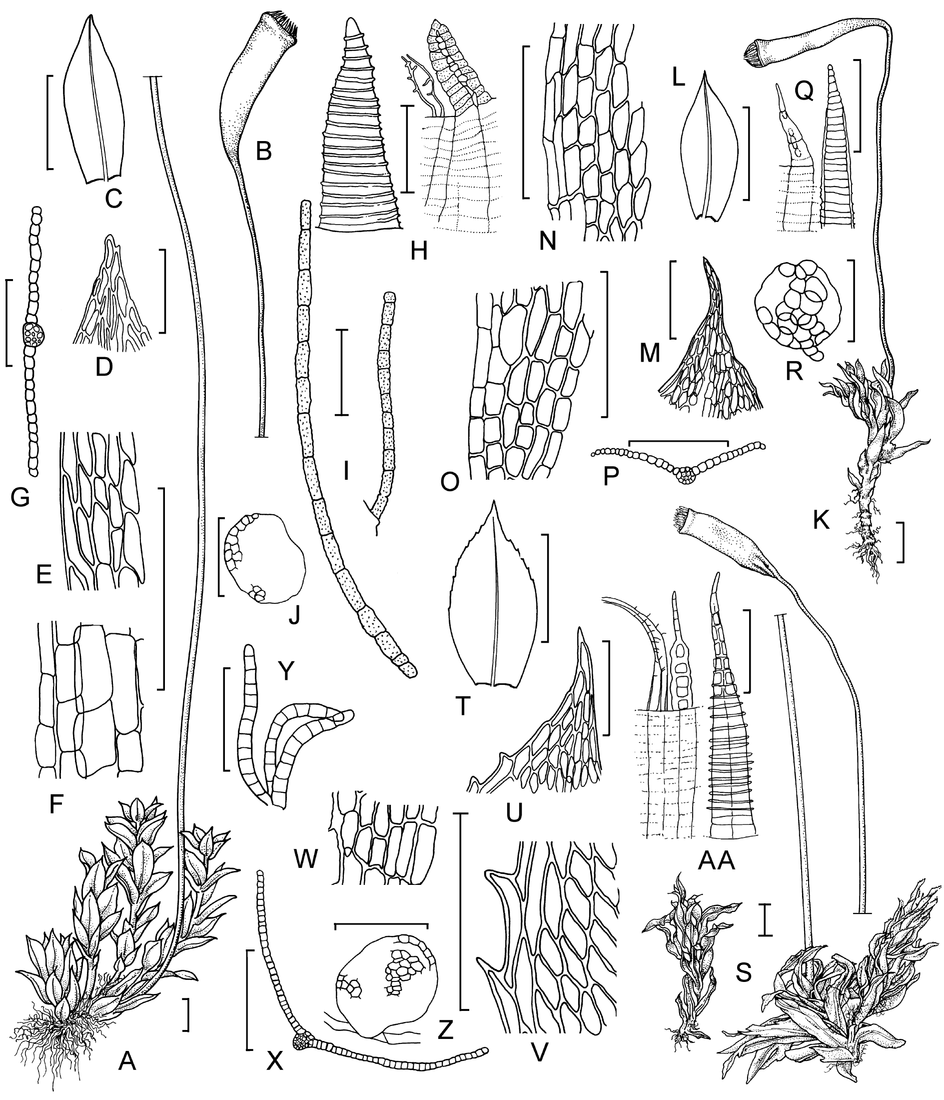

Figure 48. *Rosulabryum*. **A–J**, *R. epiphyticum*. **A**, Habit of moist plant; **B**, Capsule; **C**, Leaf; **D**, Cells at leaf apex; **E**, Mid-leaf cells; **F**, Basal laminal cells; **G**, T.S. of leaf; **H**, Peristome: exostome tooth (left); basal membrane with cilium and segment (right); **I**, Filamentous gemmae; **J**, Rhizoidal tuber (A–J, holotype). **K–R**, *R. queenslandicum*. **K**, Habit with sporophyte (dry specimen); **L**, Leaf; **M**, Cells at leaf apex; **N**, Mid-leaf cells; **O**, Basal laminal cells; **P**, T.S. of leaf; **Q**, Peristome: endostome basal membrane with segment (left); exostome tooth (right); **R**, Rhizoidal tuber (K–R, holotype). **S–AA**, *R. lamingtonicum*. **S**, Habit of dry fertile specimen (right) and sterile specimen (left); **T**, Leaf; **U**, Cells at leaf apex; **V**, Upper laminal cells and margin; **W**, Basal laminal cells; **X**, T.S. of leaf; **Y**, Filamentous gemmae; **Z**, Rhizoidal tuber; **AA**, Peristome: endostome basal membrane with cilium and segment (left); exostome tooth (right) (S, X, holotype; T–W, Y–AA, *J.R.Spence*, *5192* NSW). Scale bars: 1 mm for habit; 0.5 mm for leaves; 100 µm for cellular drawings. Drawn by N.Oram.

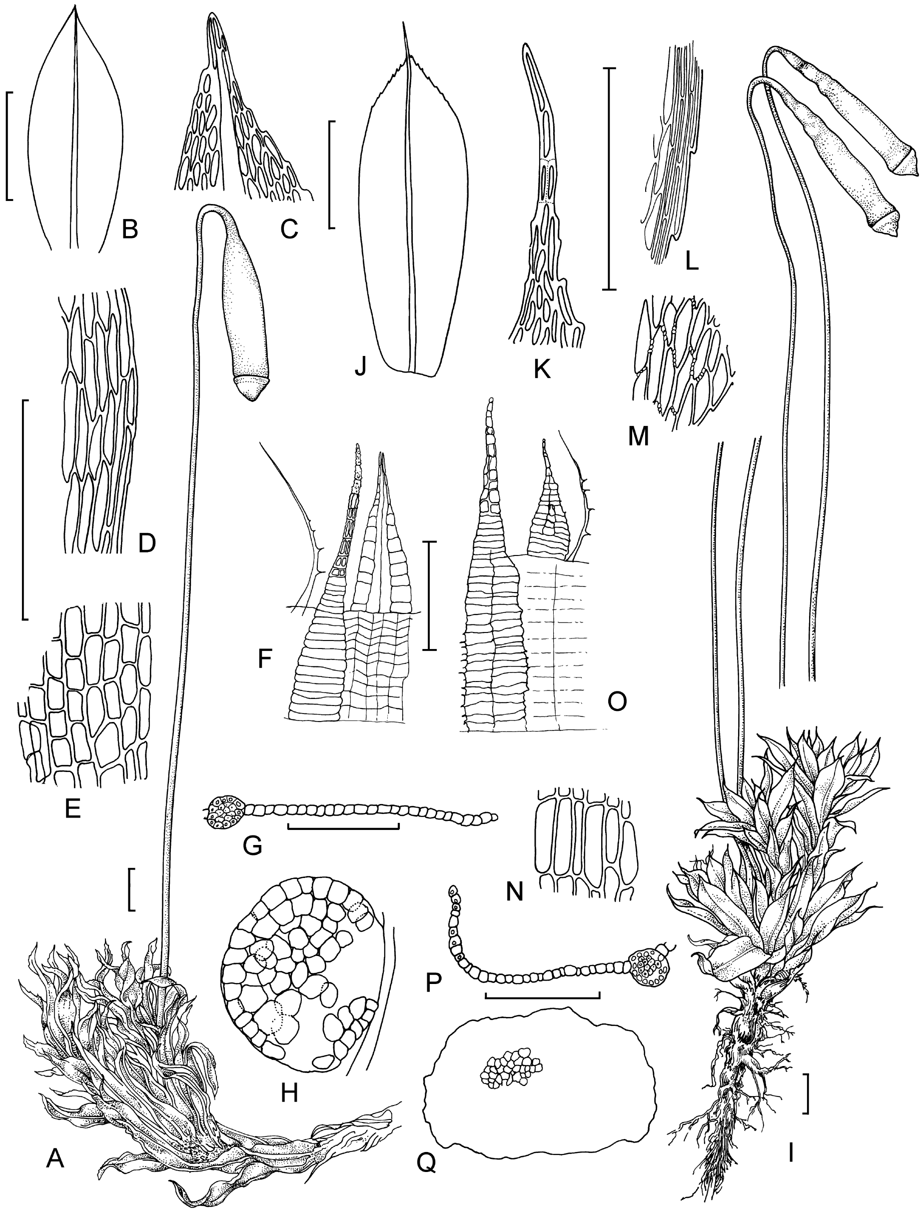

Figure 49. *Rosulabryum*. **A–H**, *R. subfasciculatum*. **A**, Habit with sporophyte (dry specimen) (isotype of *Bryum dilatatomarginatum*, NSW); **B**, Leaf; **C**, Cells at leaf apex; **D**, Mid-leaf cells; **E**, Basal laminal cells; **F**, Peristome: endostome cilium (left); exostome tooth (centre); endostome basal membrane and segment (right); **G**, T.S. of leaf; **H**, Gemma (rhizoidal tuber) (B–H, *H.P.Ramsay 26/79*, NSW). **I–Q**, *R. subtomentosum*. **I**, Habit with sporophytes (dry specimen) (*D.E.A.Catcheside s.n.*, AD); **J**, Leaf; **K**, Cells at leaf apex; **L**, Leaf margin; **M**, Mid-leaf cells; **N**, Basal laminal cells; **O**, Peristome: exostome tooth (left); endostome basal membrane with segment and cilium (right); **P**, T.S. of leaf; **Q**, Gemma (rhizoidal tuber) (J–Q, *H.P.Ramsay 25/77*, NSW). Scale bars: 1 mm for habit; 0.5 mm for leaves, 100 µm for cellular drawings. Drawn by L.Elkan.

This species is closely related to *R. campylothecium* which also has concave, imbricate leaves. However, *R. microrhodon* has a very short, recurved arista, and it tends to have a bright red-green colour. *Rosulabryum campylothecium* has a long straight hairpoint and is golden-brown. The latter is usually found at low elevations in temperate Australia.

Rosulabryum microrhodon was placed into synonymy with *Bryum billarderi* by Sainsbury (1955) and Ochi (1970), but it was accepted as a distinct species by Mohamed (1979). Previously considered an Australian endemic, *B. microrhodon* has recently been collected at high elevations in north-west Nelson, in the South Island of New Zealand (Spence, unpublished data).

9. Rosulabryum queenslandicum J.R.Spence & H.P.Ramsay, *Telopea* 8: 326 (1999)

T: track to Aljon Falls, Carnarvon Gorge Natl Park, Qld, 2 Jan. 1993, *J.R.Spence* 5167; holo: BRI.

Illustration: J.R.Spence & H.P.Ramsay, *op. cit.* 329, fig. 2.

Dioicous. Plants small, to 5 mm tall, visible as bright green shoots sometimes mixed with other mosses. Stems unbranched or with a few subfloral innovations, often leafy throughout, sparsely tomentose. Rhizoids pale brown, papillose. Leaves crowded into a rosette on fertile stems, smaller below; sterile innovations with equidistant leaves; leaves narrowly ovate to obovate, 0.5–1.5 mm long, contorted when dry, erect-spreading when moist; margin plane, entire throughout or, rarely, finely serrulate above, unbordered; costa variable, golden-brown, not reaching apex to short-excurrent in a stout mucro; apiculus present if costa not excurrent; upper and middle laminal cells irregularly rhomboidal, 35–50 × 12–18 µm (2–3: 1), becoming longer and more rectangular below. Gemmae as small irregularly globose elliptical or pyriform rhizoidal tubers, often present on long rhizoids in substratum, reddish brown or orange-brown, darker than rhizoids, 50–150 µm wide; cells 25–50 µm wide; filamentous gemmae absent. Perigonial and perichaetial leaves crowded; inner leaves smaller than outer, ovate-lanceolate to triangular, with strongly bordered margins, serrulate above; innermost leaves very small, broadly ovate to obovate. Setae 5–8 mm long. Capsules cylindrical, inclined, c. 2 mm long, brownish, wider than urn at mouth. Spores 8–13 µm diam. Chromosome number not known. Fig. 48K–R.

A very rare, endemic species known from one locality in N.T. and three in Qld, found on soil banks in shaded areas. Map 201.

N.T.: 3.2 km NE of Mt Ziel trig. station, *A.C.Beauglehole 27344* (MEL). Qld: Mt Nebo, *I.G.Stone 13132* (MEL); Blackdown, *I.G.Stone 20226* (MEL).

Superficially, *R. queenslandicum* resembles *Gemmabryum radiculosum*. However, it can be distinguished by the leaf shape, leaf margin and border and the shape of the capsules. The former has mostly ovate to obovate leaves that are ±entire, a plane border and elongate-cylindrical capsules with a wide mouth. By contrast, *G. radiculosum* and its allies have ovate-lanceolate leaves, serrate upper leaf margins, strongly revolute borders and pyriform capsules with mouths that are narrower than the urn.

10. Rosulabryum subfasciculatum (Hampe) J.R.Spence, *Bryologist* 99: 223 (1996)

Rhodobryum subfasciculatum Hampe, *Linnaea* 40: 312 (1876); *Bryum subfasciculatum* (Hampe) Mitt., *Trans. & Proc. Roy. Soc. Victoria* 19: 73 (1882). T: Qld, locality unknown, *Eaves*; holo: BM; iso: H.

Bryum subleptothecium Müll.Hal., *Rev. Bryol.* 3: 3 (1876), *nom. nud*. Based on: near Sydney, N.S.W., *D.Kayser* (NSW).

Bryum dilatatomarginatum Müll.Hal., *Hedwigia* 37: 102 (1898); *Rhodobryum dilatatomarginatum* (Müll.Hal.) Paris, *Index Bryol.*, Suppl. 1: 299 (1900). T: Cambewarra, N.S.W., Dec. 1885, [*T.Whitelegge*]; holo: H-BR; iso: NSW, S.

Bryum subolivaceum Müll.Hal., *Hedwigia* 37: 103 (1898); *Rhodobryum subolivaceum* (Müll.Hal.) Paris, *Index Bryol.*, Suppl. 1: 300 (1900). T: The Clyde, N.S.W., Oct. 1884, *W.Baeuerlen*; holo: MEL *n.v.*

Bryum amoenum Wright ex Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 126 (1906), *nom. nud.* (in synon.). Based on: Tintenbar, Richmond R., Ballina District, N.S.W., *W.Baeuerlen 1613* (NSW).

Bryum subviolaceum Müll.Hal. ex F.M.Bailey, *Compr. Cat. Queensland Pl.* 662 (1913), *nom. nud., error. pro B. subolivaceum* Müll.Hal.

Bryum leucoloma Broth., *Proc. Linn. Soc. New South Wales* 60: 93 (1935), *nom. nud.* (in synon.). Based on: Shellharbour, N.S.W., 1 Oct. 1899, *E.Cheel 408* (NSW).

Bryum chrysophyllum Ochi, *Hikobia* 6: 220 (1973). T: "in locis paludosis montis Coumboui, loco dicto Dent Saint-Vincent", New Caledonia, *Balansa* 2977; holo: *n.v.*

Illustrations: M.A.Haji Mohamed, *J. Bryol.* 10: 445, fig. 22; 446, fig. 23 (1979), as *Bryum billardierei* var. *platyloma*.

Dioicous. Plants loose or tufted, 1–5 cm tall, yellowish green or green, lustrous in upper parts, with a brown tomentum below. Stems simple or, occasionally, branched by 1 or 2 subperichaetial innovations, usually erect, sometimes flexuose. Rhizoids brown to reddish brown, coarsely papillose. Leaves usually rather distantly arranged on stem, only forming a distinct rosette when surrounding perichaetia, not twisted, sometimes spreading, keeled; upper leaves often folded lengthwise, ovate or obovate to lanceolate, 2.3–6.6 mm long (3–4: 1), widest 50–67% from the base; apex mucronate to cuspidate; margin distinctly serrate in upper 25–50% of leaf, the lower half reflexed or plane; border moderately distinct, with 2 or 3 rows of elongate cells, yellowish in older leaves; costa short- or moderately excurrent, reddish below, yellowish green above; upper laminal cells elongate-rhomboidal, occasionally hexagonal, 50–80 × 13–17 µm; cell walls thin to firm but not distinctly incrassate; basal cells rectangular. Gemmae on short rhizoids, pale red to orange-red, scattered, round or oval, 180–530 µm wide; filamentous gemmae absent. Setae 15–35 mm long. Capsules horizontal to cernuous when dry, pendulous when moist, symmetrical, clavate-pyriform, 4–6 mm long, contracted below mouth when dry. Spores 10–15 µm diam. $n = 10$, *fide* H.P.Ramsay & J.R.Spence, *J.Hattori Bot. Lab.* 80: 262 (1996). Fig. 49A–H.

Occurs in W.A., S.A., Qld, N.S.W., Vic. and Tas.; grows mainly on soil, in sand dunes or on the forest floor. Also in New Caledonia. Map 202.

W.A.: Chudalup, *I.G.Stone 6325* (MEL). Qld: Big Tableland, S of Cooktown, *H.Streimann 30728* (CANB). N.S.W.: 'Kingwell', Wyong, *W.W.Watts 9772* (NSW). Vic.: Hedditch waterhole, Winnup to Dartmoor, *I.G.Stone s.n.* (MEL). Tas.: Ettrick R., King Is., *L.D.Cameron 616* (MEL).

Rosulabryum subfasciculatum has often been confused with *R. billarderi*; however, it can be distinguished by the non-rosulate stems with leaves that are equidistant although somewhat tufted above, smaller tubers and more ovate-lanceolate and carinate leaves with margins that are more strongly serrate above.

11. Rosulabryum subtomentosum (Hampe) J.R.Spence, *Bryologist* 99: 223 (1996)

Rhodobryum subtomentosum Hampe, *Linnaea* 36: 516 (1870); *Bryum subtomentosum* (Hampe) Mitt., *Trans. & Proc. Roy. Soc. Victoria* 19: 73 (1822). T: Vic., [locality not known], *F.Mueller 56*; holo: BM; iso: H, NSW.

Bryum platyloma Schwägr., *Sp. Musc. Frond.*, Suppl. 1, 2: 116 (1816); *Bryum billarderi* Schwägr. var. *platyloma* Mohamed, *J. Bryol.* 10: 412 (1979). T: Cascade Creek, Eglinton, South Island, New Zealand, May 1971, *J.Child 2713*; neo: GL; isoneo: BM, JC.

[*Bryum perlimbatum auct. non* Cardot: H.Streimann & A.Touw, *J. Hattori Bot. Lab.* 49: 262 (1981)]

Illustrations: M.A.Haji Mohamed, *J. Bryol.* 10: 413, fig. 5 (1979), as *Bryum billarderi* var. *platyloma*; J.R.Spence & H.P.Ramsay, *J. Adelaide Bot. Gard.* 17: 111, fig. 2 (1996), as *R. subfasciculatum*.

Dioicous. Plants tufted, to 2 cm tall, or sometimes with elongate sparingly branched pendent stems to 10 cm long; older parts of stems becoming denuded of leaves; older stems and leaves often blackish. Rhizoids brown to reddish brown, densely papillose. Leaves often spreading, rarely concave, contorted when dry, erect-spreading when moist, spathulate, 4–6 mm long; apex acute; margin distinctly toothed above, strongly recurved in lower three-quarters; border whitish, broad, with 4–8 rows of narrow elongate incrassate cells; costa moderately to long-excurrent, golden or brown-green; upper laminal cells rhomboidal-hexagonal, 40–80 × 12–20 µm; basal cells ±broadly rectangular. Gemmae as rhizoidal tubers, scattered, sometimes abundant, produced on short rhizoids, orange to red, globose or oval, (300–) 500–1000 µm in longest axis, with 10–25 cells across face; cell walls not projecting. Setae 20–40 mm long, usually bent into a hook below the capsule. Capsules suberect to horizontal when dry, cernuous to pendulous when moist, often incurved, symmetrical, long-cylindrical or narrowly oblong, 2.5–6.5 mm long, contracted below the large mouth when dry. Spores 12–16 µm diam. $n = 10$, *fide* H.P.Ramsay & J.R.Spence, *J. Hattori Bot. Lab.* 80: 261 (1996). Fig. 49I–Q.

Occurs in W.A., S.A., Qld, N.S.W., Vic. and Tas.; commonly found on splashed rocks along streams or near waterfalls, especially at higher elevations. Also widespread in New Zealand and its offshore islands. Map 203.

W.A.: Cascades, near Pemberton, *D.G.Catcheside 74.179* (AD). S.A.: S of Ashbourne, 23 Sept. 1978, *D.E.A.Catcheside* (AD). Qld: Toowoomba, *F.M.Bailey s.n.* (BRI). N.S.W.: Crackenback R., 6 km NW of Jindabyne, *H.Streimann 3962* (NSW). Vic.: near Chimney Pots, Grampians Natl Park, *J.R.Spence 4366* (NSW). Tas.: Liffey Falls, *J.R.Spence 4691* (NSW).

Although this species is closely related to *R. billarderi*, a suite of distinguishing characters readily separate them. These include a thicker leaf border in *R. subtomentosum* (4–8 as opposed to 1 or 2 layers) thus giving a whitish edge to the spathulate rather than obovate leaves. The setae are hooked just below the capsules in about 90% of *R. subtomentosum* collections (Mohamed, 1979), but only in 10–20% of *R. billarderi* specimens.

12. Rosulabryum torquescens (Bruch ex De Not.) J.R.Spence, *Bryologist* 99: 223 (1996)

Bryum torquescens Bruch ex De Not., *Syll.* 163 (1838); *Bryum capillare* Hedw. subsp. *torquescens* (Bruch ex De Not.) Kindb., *Eur. N. Amer. Bryin.* 2: 358 (1897). T: Sardinia, Italy, 1828, *C.Müller*; *n.v.*

Bryum pyrothecium Müll.Hal. & Hampe, *Linnaea* 26: 495 (1855); *Rhodobryum pyrothecium* (Müll.Hal. & Hampe) Paris, *Index Bryol*. 1119 (1898). T: Moe Swamp, Vic., *F.Mueller*; holo: MEL.

Bryum erythropyxis Müll.Hal., *Hedwigia* 37: 101 (1898); *Rhodobryum erythropyxis* (Müll.Hal.) Paris, *Index Bryol*., Suppl. 1: 299 (1900). T: Hume R., N.S.W., *F.M.Campbell*; syn: MEL; Cambewarra, N.S.W., Dec. 1885, *T.Whitelegge*; syn: H-BR, NSW.

Bryum erythropyxis Müll.Hal. var. *minor* Broth. ex Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 132 (1906), *nom. nud.* Based on: Newrybar, Brooklet and Pearces Ck, Richmond R., N.S.W., Dec. 1899, *W.W.Watts* (NSW).

Bryum synoicum Müll.Hal., *Hedwigia* 37: 96 (1898). T: Bells Head [Balls Head] Bay, N.S.W., Aug. 1884, *T.Whitelegge*; syn: MEL; isosyn: NSW; Randwick Rd, [Sydney, N.S.W.], Sept. 1884, *T.Whitelegge*; syn: MEL; Bunya Mtns, Qld, May 1885, *F.M.Bailey*; syn: H-BR; isosyn: MEL; S.A., [locality not known], *F.M.Campbell*; syn: H-BR.

Bryum subtorquescens Geh., *in* W.W.Watts & T.Whitelegge, *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 140, 141 (1906), *nom. nud.* (in synon.). Based on: Cambewarra, N.S.W., 29 Sept. 1885, *C.Harris* (MEL).

Illustrations: H.Syed, *Bryologist* 77: 308, fig. 23; 309, fig. 24 (1973), as *B. torquescens*; D.G.Catcheside, *Mosses of South Australia* 258, fig. 148 (1980), as *B. torquescens*.

Polyoicous. Plants in loose or dense tufts, 10–25 mm tall, green to reddish green. Rhizoids bright red to brown, finely papillose. Leaves plane or concave, ovate, obovate or spathulate, mucronate or cuspidate, scarcely shrinking, slightly twisted or spreading to closely appressed when dry, spirally twisted around the stem, erect-spreading when moist; margin recurved, bordered, toothed (sometimes strongly); costa strongly excurrent in a mucronate to piliferous hairpoint, brown to red; upper laminal cells narrowly hexagonal, 30–55 × 13–22 µm (2–3: 1); basal cells narrowly rectangular; marginal rows elongate, incrassate, forming a distinct border. Gemmae rhizoidal, globose, 75–255 µm diam., red or orange, on long and short rhizoids; cell walls usually not projecting; filamentous axillary gemmae absent. Setae 20–40 mm long. Capsules cernuous or subpendulous, symmetrical, subcylindrical to cylindrical, 3–5 mm long, red or reddish brown; mouth often red. Endostome segments abruptly apiculate, with rounded shoulders. Spores 11–15 µm diam. *n* = 20, *fide* H.P.Ramsay & J.R.Spence, *J. Hattori Bot. Lab*. 80: 262 (1996). Fig. 50A–H, Plate 43.

Occurs in W.A., S.A., N.S.W., A.C.T., Vic. and Tas.; a ±cosmopolitan species in semi-arid and seasonal temperate and subtropical regions. Map 204.

W.A.: 56 km SSE of Carnamah, *A.C.Beauglehole 14167* (MEL). S.A.: Murray R., near Coomandook, *L.D.Williams 1031* (AD). N.S.W.: Warrumbungle Ra., *W.Forsyth 1023* (NSW). A.C.T.: Molongolo Gorge, *J.R.Spence 4490* (NSW). Vic.: Buninyong, Sept. 1898, *R.A.Bastow* (MEL). Tas.: Kangaroo Pt, *A.J.Taylor 778* (MEL).

Australian collections include many dioicous or perhaps rhizautoicous forms. If not synoicous, *R. torquescens* can be confused with *R. capillare*, but it differs in having red capsules, bright red rather than reddish brown rhizoidal gemmae, paler rhizoids and a longer

leaf hairpoint. The leaves are generally contorted but not spirally twisted as in *R. capillare*, and the upper margins are more strongly serrate. In Australia, this species is far more common than *R. capillare*.

13. **Rosulabryum tuberosum** (Mohamed & Damanhuri) J.R.Spence, *Bryologist* 99: 223 (1996)

Bryum tuberosum Mohamed & Damanhuri, *Bryologist* 93: 288 (1990). T: Genting Highlands, Pahang, Malaysia, *M.A.Hadji Mohamed 5397*; holo: KLU; iso: UKMB.

Illustration: M.A.Hadji Mohamed & A.Damanhuri, *op. cit.* 289, fig. 1 (1990), as *Bryum tuberosum*.

Dioicous. Plants small to medium-sized, 5–10 mm tall, loosely tufted, green to reddish green, reddish when older, radiculose at base. Rhizoids reddish brown to brown. Leaves shrunken and contorted when dry, erect-spreading when moist, sometimes forming a terminal rosette, broadly to narrowly ovate, 2–3 mm long, acuminate; apex short-mucronate; margin entire; border weak, of 3 or 4 rows of elongate cells; costa slender, percurrent to short-excurrent as a slender point; upper laminal cells elongate-rhomboidal to hexagonal, 65–125 × 10–20 µm; basal cells long-rectangular, 40–105 µm long (3–4: 1). Gemmae as rhizoidal tubers, abundant, reddish brown, from macronemata arising in leaf axils or on rhizoids, flattened with undulate margins due to wall shrinkage on drying, 3–7 cells across face. Sporophytes not present in Australian collections. Fig. 50I–N.

Known from two localities in north-eastern Qld; possibly introduced. Also in Malaysia and New Guinea (J.R.Spence, unpublished data). Map 205.

Qld: Crystal Cascades, Mt Spec, near Townsville, *I.G.Stone 16751* (MEL); Dunk Is., *I.G.Stone s.n.* (MEL).

The elongate laminal cells, ovate leaves and very unusual tubers are diagnostic. The tubers are very different from those of other Australasian species, being flattened and often originating in the leaf axils as well as on rhizoids. The affinities of this species are not known.

14. **Rosulabryum wightii** (Mitt.) J.R.Spence, *Bryologist* 99: 223 (1996)

Bryum wightii Mitt., *J. Proc. Linn. Soc., Bot.*, Suppl. 1: 74 (1859). T: southern India; holo: BM.

Bryum semperlaxum Müll.Hal., *Linnaea* 38: 582 (1874); *Brachymenium semperlaxum* (Müll.Hal.) A.Jaeger, *Ber. Tätigk. St. Gallischen Naturwiss. Ges.* 1873–74: 114 (1875) (Ad. 1: 576). T: Brisbane R., Qld, Oct. 1867?, *A.Dietrich*; holo: *n.v.*

Illustrations: H.C.Gangulee, *Mosses of Eastern India and Adjacent Regions* 2: 984, fig. 475 (1974); M.A.Haji Mohamed, *J. Bryol.* 12: 24, fig. 1 (1982), both as *Bryum wightii*.

Dioicous. Plants robust, densely tufted, green above, reddish below. Stems erect, to 10 cm tall, branched by several subperichaetial innovations, red, tomentose below. Rhizoids red. Leaves equidistant along stem or somewhat smaller and more distant below and larger above and more crowded at apex, erecto-patent to erect-spreading, curled and crispate when dry, erect-spreading when moist, mostly ovate, rarely oblong to oblong-spathulate, concave, 5–9 mm long, 1–2 mm wide; older leaves reddish; apex acute; lower margin reflexed and entire, flat and dentate near apex; border moderately distinct, 1 or 2 rows of narrow elongated cells; costa brown, strongly excurrent in a short stout denticulate arista; upper laminal cells slightly thickened, rhomboidal, to 80 µm long (3–4: 1); lower cells rectangular and more elongate, with thinner walls. Gemmae absent. Perigonial leaves greatly enlarged in a comal tuft, similar in shape to vegetative leaves. Setae 20–30 mm long, erect, arcuate at tip, often polysetose, brown. Capsules large, clavate, 5–7 mm long, arcuate; mouth wide, usually oblique. Spores 12–18 µm diam. Chromosome number not known. Fig. 50O–V.

Montane to alpine in eastern Qld, N.S.W. and Vic. Also in India. Map 206.

Qld: Powelltown, 12 Dec. 1929, *J.H.Willis s.n.* (MEL, NSW); Elinjaa Falls, *I.G.Stone 24276*, *24277* (MEL). N.S.W.: Gloucester R., 28 km WSW of Gloucester, *H.Streimann 6469* (CANB). Vic.: Mt Baw Baw, *R.A.Bastow s.n.* (MEL).

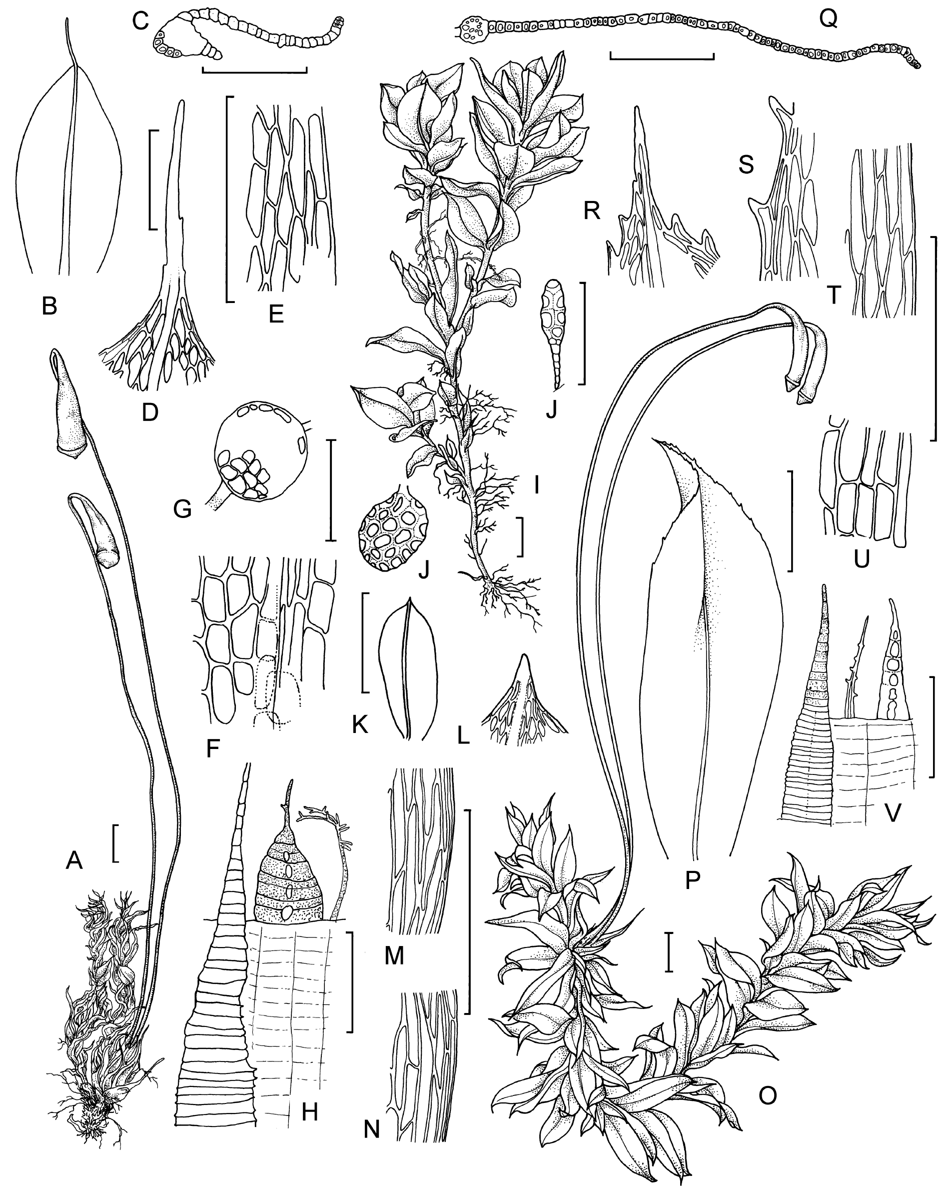

Figure 50. *Rosulabryum*. **A–H**, *R. torquescens*. **A**, Habit with sporophyte (dry specimen); **B**, Leaf (A, B, *D.G.Catcheside 78.286*, AD); **C**, T.S. of leaf (*H.P.Ramsay 45/84*, NSW); **D**, Cells at leaf apex; **E**, Mid-leaf cells; **F**, Basal laminal cells, **G**, Rhizoidal tuber; **H**, Peristome: exostome tooth (left); endostome basal membrane with segment and cilium (right) (D–H, *H.P.Ramsay 54/84*, NSW). **I–N**, *R. tuberosum*. **I**, Habit; **J**, Rhizoidal tuber; **K**, Leaf; **L**, Cells at leaf apex; **M**, Mid-leaf cells; **N**, Basal laminal cells (I–N, *I.G.Stone 16751*, MEL). **O–V**, *R. wightii*. **O**, Habit with sporophytes; **P**, Leaf; **Q**, T.S. of leaf; **R**, Cells at leaf apex; **S**, Upper leaf marginal cells; **T**, Mid-leaf cells; **U**, Basal laminal cells (O–U, *I.G.Stone 24277*, MEL); **V**, Peristome: exostome tooth (left); endostome basal membrane with cilium and segment (right) (*H.Streimann 4842*, AD). Scale bars: 1 mm for habit; 0.5 mm for leaves, 100 µm for cellular drawings. Drawn by L.Elkan.

Rosulabryum wightii is a robust species that is often larger than *Rhodobryum aubertii*. Although the two can be confused, *R. wightii* has much enlarged gametangia, a well-developed stereid band in the costa, and the leaves hydrate rather quickly. Although very close to the south Indian type specimen, there are some subtle differences between specimens from across its range which warrant further study.

LEPTOSTOMACEAE

Helen P. Ramsay[1]

Leptostomaceae Schwägr., *in* C.L. von Willdenow, *Sp. Pl.* 5(2): 85 (1830); often cited incorrectly as "Leptostomataceae".

Type: *Leptostomum* R.Br.

Dioicous. Plants small to moderately robust, growing in vivid green to dull green cushions matted by a dense dark brown to rust-red tomentum to form a hard corky pad. Stems erect, simple or branched, held together by a thick tomentum of rhizoids that are dimorphic and either thicker and with a coarsely papillose-scaly surface, or finer and almost smooth. Leaves erect and ±twisted around the stem or erect-spreading when dry, erect-spreading when moist, oblong-oval to ovate, broadly rounded to emarginate or broadly acute, abruptly piliferous; margin entire or rarely somewhat serrulate near apex, when dry mostly reflexed to revolute, unbordered; costa prominent at back, excurrent in a hyaline hairpoint or rarely ending below hairpoint; laminal cells subquadrate or rounded-hexagonal and firm to thick-walled or, less commonly, hexagonal and thin-walled, smooth, somewhat longer and broader towards the base, often thick-walled in the recurved marginal region, not differentiated in the alar region. Perichaetia and perigonia terminal and filiform. Calyptra pale brown, slenderly cucullate, smooth, glabrous. Setae elongate, smooth. Capsules erect or ±inclined, sometimes curved or asymmetrical, oblong-oval or long-symmetrical, small-mouthed, with the neck broadly or long-tapered to the seta, smooth; operculum dome-like or rarely ±flat, not or only minutely apiculate; stomata numerous in neck, superficial. Peristome diplolepidous, double, brilliant white, often fragile or reduced; exostome teeth very short, smooth or papillose; endostome a small membrane; sometimes the exostome and endostome rudimentary and fused. Spores papillose with large hollow processes.

A monotypic family of eight species, Leptostomaceae is Gondwanan in origin and is distributed from the southern tip of South America to New Zealand and Australia northward through New Guinea, the Celebes and Java to Sri Lanka. Three non-endemic species occur in Australia.

The genus *Leptostomum* has variously been placed in the Bryaceae (Mitten, 1860; Andrews, 1951; Ochi, 1972; Crosby & Magill, 1988) or in Leptostomaceae (Bryiineae) close to Bryaceae and Mniaceae and near the Bartramiineae (e.g. Brotherus, 1924; Vitt, 1984). Scanning electron microscopy of spores support a closer relationship with Bartramiineae rather than Bryiineae (Sorsa, 1976), while Ramsay (1983) saw a possible relationship to Mniaceae based on chromosome number (not supported by the superficial stomata); however n = 6 could also indicate the Bartramiineae. Chromosome number and spore characteristics together with cell structure and other attributes have led a number of taxonomists to accept ties to the Bartramiineae, a decision supported by Crum (1992) and followed in the current treatment.

W.Mitten, Descriptions of some new species of Musci from New Zealand…, *J. Proc. Linn. Soc., Bot.* 4: 64–100 (1860), V.F.Brotherus, *Leptostomum*, *Nat. Pflanzenfam.*, 2nd edn, 10: 404–406 (1924) A.L.Andrews, Taxonomic notes X. Leptostomaceae, *Bryologist* 54: 217–223 (1951); H.Ochi, Some problems of distributional patterns and speciation in the subfamily Bryoideae in regions including Eurasia, Africa and Oceania, *J. Hattori Bot. Lab.* 35: 50–67 (1972); H.P.Ramsay, Cytological studies of Australian mosses, *Austral. J. Bot.* 22: 293–348 (1974); P.Sorsa, *Evolutionary Significance of the Exine* 211–229 (1976); H.P.Ramsay, Cytology of mosses, *New Manual of Bryology* 1: 149–221 (1983); D.H.Vitt, Classification of the Bryopsida, *New Manual of Bryology* 2: 746 (1984); T.Koponen & D.H.Norris, Bryophyte flora of the Huon Peninsula, Papua New Guinea. XI. *Brachymenium*, *Epipterygium*, *Leptobryum*, *Mielichhoferia*, *Orthodontium* and *Pohlia* (Bryaceae) and Lepstostomataceae

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(Musci), *Acta Bot. Fenn.* 131: 99–127 (1985); J.Hyvönen, A synopsis of *Leptostomum* R.Br. (Leptostomataceae, Musci), *Ann. Bot. Fenn.* 24: 63–72 (1987); C.M.Matteri, The genus *Leptostomum* R.Br. in southern South America, *J. Hattori Bot. Lab.* 69: 257–264 (1991); H.Crum, A reconsideration of the Leptostomataceae, *J. Hattori Bot. Lab.* 72: 127–139 (1992); C.J.Cox & T.A.J.Hedderson, Phylogenetic relationships among the ciliate arthrodontous mosses: evidence from chloroplast and nuclear DNA sequences, *Pl. Syst. Evol.* 215: 119–139 (1999); C.J.Cox, B.Goffinet, A.E.Newton, A.J.Shaw & T.A.J.Hedderson, Phylogenetic relationships among the diplolepideous-alternate mosses (Bryideae) inferred from nuclear and chloroplast DNA sequences, *Bryologist* 103: 224–241 (2000); W.R.Buck & B.Goffinet, Morphology and classification and mosses, *in* J.Shaw & B.Goffinet (eds), *Bryophyte Biology* 71–123 (2000).

LEPTOSTOMUM

Leptostomum R.Br., *Trans. Linn. Soc. London* 10: 320 (1811), *nom. cons.*; from the Greek *lepto-* (small) and *stomas* (a mouth), in reference to the narrow mouth of the capsule.

Lecto: *L. inclinans* R.Br.

Helmsia Bosw., *J. Bot.* 32: 82 (1894). T: *H. collina* Bosw. [= *Leptostomum macrocarpon* (Hedw.) Bach.Pyl.]

Plants conspicuously matted together to form a characteristic hard corky tomentum. Leaves piliferous, unbordered; margin recurved; laminal cells small, almost isodiametric to short-rectangular. Capsules generally erect, with a short to long neck with superficial stomata and a narrow mouth with a convex or dome-like operculum; annulus absent or poorly developed.

Species are often epiphytic on tree trunks and shrubs, but they can also occur on rock in closed forest (rainforest or wet-sclerophyll forest) and in riparian habitats.

1 Hairpoints of uppermost vegetative and perichaetial leaves ciliate-branched and, when dry, flexuose-crisped; laminal cells thin-walled, the contents conspicuously stellate-shrunken when dry........ **3. L. macrocarpon**

1: Hairpoints simple, not especially flexuose when dry; laminal cells thick-walled, the contents not noticeably shrunken when dry 2

2 Hairpoints of vegetative leaves elongate; margin broadly and strongly revolute; leaf apex entire, symmetrical; cells 10–20 µm, only moderately thick-walled; leaves usually tightly spirally twisted around stem when dry; capsules with a short neck broadly tapering to the seta *(1:)*...... **1. L. erectum**

2: Hairpoints of vegetative leaves usually short; margin narrowly revolute; leaf apex slightly toothed and somewhat asymmetrical; cells 9–12 µm, very thick-walled; leaves erect, scarcely twisted around stem when dry; capsules with a long neck gradually tapering to the seta .... **2. L. inclinans**

1. Leptostomum erectum R.Br., *Trans. Linn. Soc. London* 10: 320 (1811)

T: Hawkesbury and Grose Rivers, "Novae Hollandiae ora orientalis", [N.S.W.], *R.Brown*; holo: BM.

Gymnostomum leptostomum Hook., *Musci Exot.* 2: 169 (1820). T: *n.v.*

Leptostomum densum Thwaites & Mitt., *J. Linn. Soc., Bot.* 13: 305 (1873). T: Central Province, Ceylon [Sri Lanka], *G.H.K.Thwaites 123*; holo: H-BR.

Illustration: J.Hyvönen, *Ann. Bot. Fenn.* 24: 69, fig. 3a–c (1987).

Stems erect, 20–40 mm tall, simple, rarely branched. Leaves crowded, imbricate and tightly spirally twisted around the stem when dry, 1–2 mm long; hairpoint on vegetative and perichaetial leaves long, hyaline, smooth; margin broadly and strongly revolute; laminal cells isodiametric, 10–16 (–20) µm, moderately thick-walled; lumina small; basal cells oblong-rectangular, moderately thick-walled. Setae 12–25 mm long. Capsules ellipsoidal, 3–4 mm long; urn narrowed toward mouth; neck short, broadly tapering to the seta. Peristome reduced, inserted well below mouth, fragile and highly variable, consisting of a pale smooth low endostomial membrane with ±irregular rudiments of segments at its apex; or with reduced exostome teeth, yellowish. Spores finely papillose, 18–25 µm diam. Chromosome number not known. Fig. 51Q–W, Plate 45.

Occurs in eastern Qld and in eastern N.S.W., A.C.T. and rare in Vic.; grows on tree trunks (*Nothofagus*, *Auraucaria*, *Eucalyptus* and *Casuarina*) and on granite rock faces at 500–1550 m. Also in Sri Lanka and New Zealand. Map 207.

Qld: Peases Lookout, Eungella, *I.G.Stone 17307* (MEL). N.S.W.: upper Shoalhaven R. valley, *H.Streimann 899* (CANB, MEL); Jenolan Caves, *Blakely 630* (NSW). A.C.T.: Hanging Rock, Tidbinbilla Valley, *D.G.Catcheside 65.50* (AD). Vic.: Coast Ra., Bendoc, *I.G.Stone 721* (MEL).

A few early collections labelled "*L. densum*" have been located in Australian herbaria, and all represent *L. erectum*. Hyvönen (1987), recognised *L. densum* as a distinct species, but he did not list it for Australia. However, Crum (1992) placed it in the synonymy of *L. erectum* and considered the "smaller size of Australian populations the result of less optimal climatic conditions", while variation in the peristome conforms to the range in *L. erectum*.

Previous incorrect identifications have placed *L. erectum* in Tas., but only a few collections have been found to occur south of the N.S.W.–Vic. border. Other Australian specimens have been incorrectly identified as *L. inclinans.* The two species are quite distinct if capsules are present but, in their absence, *L. erectum* and *L. inclinans* can be distinguished as follows: strongly and broadly revolute leaf margins, a long smooth hairpoint, apex symmetrical and leaves spirally and often tightly wound around the stem in *L. erectum*; in *L. inclinans* the leaves have a narrowly revolute border, a shorter, smooth to faintly serrulate, asymmetrical hairpoint and leaves that are more erect and not tightly wound around the stem. *Leptostomum erectum* occurs at lower elevations, and it is more tropical in its distribution than *L. inclinans*.

There is evidence that new plants can regenerate after fire from damaged corky pads.

2. **Leptostomum inclinans** R.Br., *Trans. Linn. Soc. London* 10: 320 (1811)

Gymnostomum inclinans (R.Br.) Hook., *Musci Exot.* 2: pl. 168 (1819). T: Montis Tabularis [Mt Wellington], Insula Van Diemen [Tas.], *R.Brown*; iso: BM.

Leptostomum gracile R.Br., *Trans. Linn. Soc. London* 10: 321 (1811). T: "Dusky Bay" [Dusky Sound], South Island, New Zealand, 1791, *A.Menzies*; holo: BM; iso: E.

Leptostomum flexipile Müll.Hal., *Bot. Zeitung (Berlin)* 9: 547 (1851). T: New Zealand, *coll. unknown*; holo: NY *n.v.*

Leptostomum inclinans R.Br. var. *longiseta* Hampe, *Linnaea* 28: 207 (1856), *nom. nud*. (in synon.). Based on: Sealers Cove, Vic., *F.Mueller* (BM).

Illustrations: R.Brown, *op. cit.* pl. 23, fig. 2 (1811); V.F.Brotherus, *Nat. Pflanzenfam.*, 2nd edn, 10: 406, fig. 356 (1924), as *L. gracile*; J.Beever, K.W.Allison & J.Child, *Mosses of New Zealand*, 2nd edn 99, fig. 43a–e (1992).

Plants forming large tomentose corky pads to 30 cm wide and 8 cm high, of bright pale green shoots, bright brown below. Stems erect, branched, 2–3 (–6) cm high. Leaves moderately crowded and erect when moist, closely appressed and sometimes slightly twisted around stem when dry, 1.5–2.0 (–3.0) mm long, ±oval; apex obtuse, asymmetrical and slightly serrulate; margin narrowly recurved except at the apex; costa in upper vegetative and perichaetial leaves excurrent as a short smooth to faintly denticulate unbranched hairpoint; laminal cells isodiametric, 9–12 µm, very thick-walled, smooth. Setae long-exserted, 2–5 cm long. Capsules erect to inclined, slender, 4–7 mm long, gradually narrowed to the seta through a long neck, when dry the neck narrowed and wrinkled. Peristome double; exostome teeth lacking or reduced to a very low membrane scarcely exceeding the mouth of the urn, sometimes differentiated into very short yellow tooth-fragments; endostome well developed, projecting 210–250 µm beyond the mouth as a densely papillose membrane with many short segments above. Spores 22–32 (–38) µm, bluntly and rather coarsely papillose. Chromosome number n = 6, 12, *fide* H.P.Ramsay, *Austral. J. Bot*. 22: 314 (1974). Fig. 51H–N.

Occurs in south-eastern Qld, eastern N.S.W., A.C.T., and common in Vic. and Tas.; epiphytic on trunks and branches of e.g. *Eucalyptus* and *Nothofagus* and in crevices of granitic rocks. Also in New Zealand, Campbell Is. and Macquarie Is. Map 208.

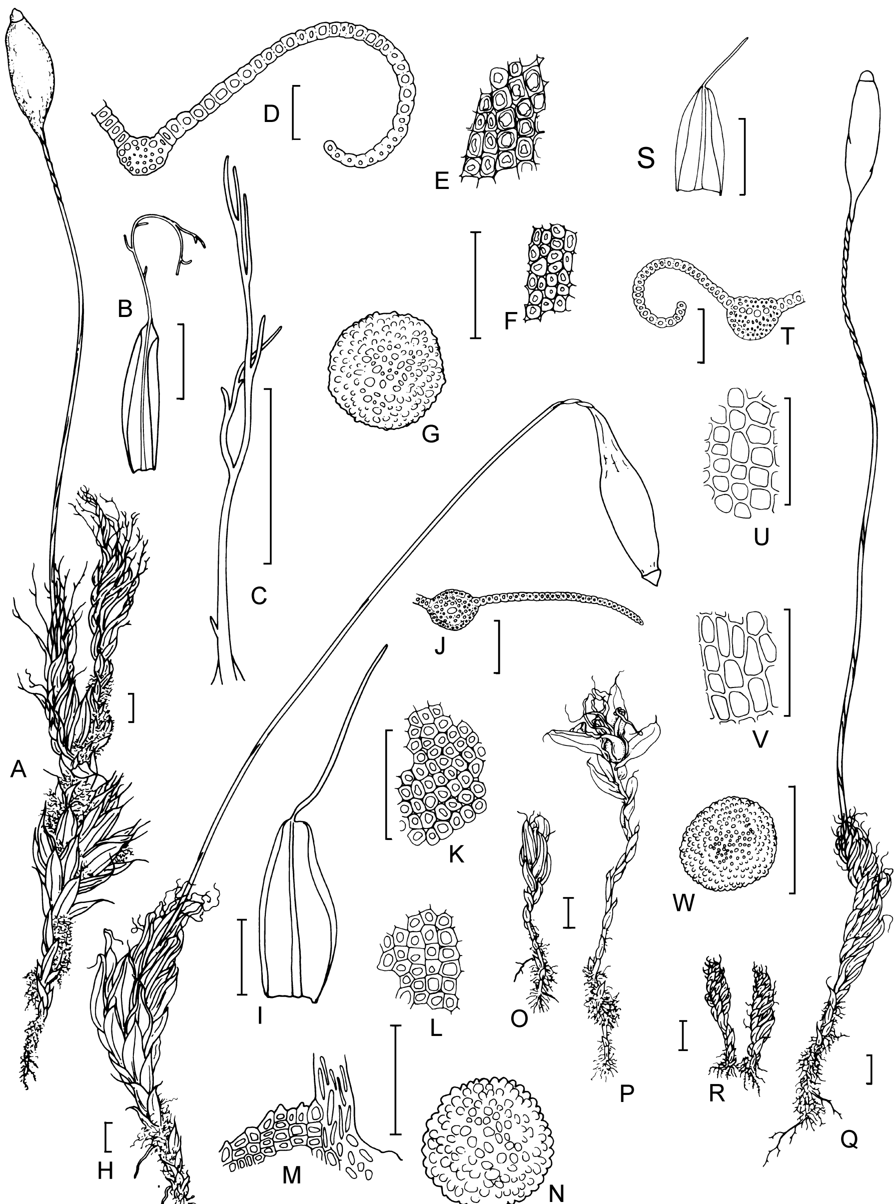

Figure 51. *Leptostomum*. **A–G**, *L. macrocarpon*. **A**, Habit with sporophyte; **B**, Leaf; **C**, Leaf apex; **D**, T.S. of leaf; **E**, Upper laminal cells; **F**, Mid-laminal cells (A–F, *W.W.Watts LHI 181*, NSW); **G**, Spore (*R.D.Hoogland 8766*, CANB). **H–N**, *L. inclinans*. **H**, Habit with sporophyte; **I**, Leaf; **J**, T.S. of leaf (H–J, *D.S.A.Adams s.n.*, MELU 52936); **K**, Mid-laminal cells; **L**, Basal laminal cells; **M**, Apical cells (K–M, *R.Gunn s.n.*, NSW); **N**, Spore (*D.S.A.Adams s.n.*, MELU 52986); **O**, Male plant (*I.G.Stone 2179*, MEL); **P**, Male plant (*I.G.Stone 3112*, MEL). **Q–W**, *L. erectum*. **Q**, Habit with sporophyte (*I.G.Stone 13321*, MEL); **R**, Male plant (*Blakeley 630*, NSW); **S**, Leaf; **T**, T.S. of leaf; **U**, Upper laminal cells; **V**, Basal laminal cells; **W**, Spore (S–W, *I.G.Stone 17836*, MEL). Scale bars: 1 mm for habit and leaves, 100 µm for cellular drawings and spores. Drawn by D.Mackay.

Qld: Beechmont Plateau, near Binna Burra, Lamington Natl Park, *D.G.Catcheside 65.323* (AD). N.S.W.: Careys Peak, Barrington Tops Natl Park, Oct. 1992, *G.J. & D.W.Harden* (NSW). A.C.T.: Booth Ra., *H.Streimann 35660* (CANB). Vic.: Major Mitchell Plateau, Grampians, *H.Streimann 3112* (CANB). Tas.: L. Dobson road, 16 km WNW of Bushy Park, *H.Streimann 39945* (CANB, HO).

Although matting of the stems usually forms a large corky pad, plants are sometimes sparse and not matted. This species is distinguished by the long setae and the many narrow, long-necked capsules that are either erect or, when inclined, appear to dangle. Sterile specimens can be distinguished by the erect leaves that are scarcely twisted around the stem, the leaves appearing broad and lax with narrowly revolute margins, and laminal cells that have small lumina and very thick walls.

3. Leptostomum macrocarpon (Hedw.) Bach.Pyl., *J. Bot. (Desvaux)*, sér. 2, 3: 15 (1814)

Bryum macrocarpon Hedw., *Sp. Musc. Frond.* 178 (1801). T: ‘Otaheiti’ [Tahiti, Society Is.]; lecto: BM *n.v.*, *fide* J.Hyvönen, *Ann. Bot. Fenn.* 24: 64 (1987).

Illustrations: J.Hyvönen, *Ann. Bot. Fenn.* 24: 65, fig. 1a–c (1987); J.Beever, K.W.Allison & J.Child, *Mosses of New Zealand*, 2nd edn 99, fig. 43f–h (1992); H.Streimann & N.Klazenga, *Cat. Austral. Mosses* [front cover] (2002).

Plants forming large green or yellow-green corky tufts 8–20 mm tall. Stems simple or branched, closely matted; more densely foliate in upper parts. Leaves erect, loosely or closely imbricate and ±twisted when dry, somewhat spirally wound around the stem, suberect when moist, ovate-oblong or obovate-oblong, 2.25–3.00 mm long; apex obtuse; margin entire, broadly to narrowly revolute; costa stout, in upper vegetative and perichaetial leaves excurrent in a long twisted-flexuose ciliate-branched hyaline hairpoint; laminal cells subquadrate or broadly hexagonal, 20–30 µm long, smooth, thin-walled; cell contents conspicuously stellate-shrunken when dry; basal cells short-oblong. Setae 10–15 (–45) mm long, pale yellow or orange, slender, flexuose. Capsules erect, ovate-oblong, 3.0–4.5 mm long; urn scarcely narrowed at base. Peristome reduced; exostome teeth scattered projections; endostome segments rudimentary, reduced to a low hyaline irregularly papillose roughened membrane. Spores 16–20 µm, finely papillose. Chromosome number not known. Fig. 51A–G, Plate 46.

A tropical to subtropical species in south-eastern Qld and N.S.W. as far south as Kiama and Fitzroy Falls; also in Lord Howe Is., Norfolk Is., New Zealand and in Polynesia as far east as the Society Is. Map 209.

Qld: Mt Merino, Macpherson Ra., *H.Streimann 350* (CANB, MEL). N.S.W.: Mt Warning, *H.Streimann 283* (CANB, MEL); Lilyvale, Sept. 1891, *coll. unknown* (NSW).

This is a striking moss with the plants matted to form large corky clumps on tree trunks, and covered with numerous long-exserted capsules. *Leptostomum macrocarpon* is readily distinguished from other species by the broader leaves with long, twisted-flexuose, ciliate-branched hairpoints on the upper vegetative and perichaetial leaves. The leaves are imbricate-curved and somewhat twisted around the stem when dry with the margins strongly and broadly revolute. The very thin-walled laminal cells with contents that are conspicuously shrunken, central and somewhat stellate in appearance in the dried condition are also distinctive, as is the comparatively broad, short capsule with a narrow mouth. The distributions of *L. erectum* and *L. macrocarpon* overlap.

Excluded Name

Leptostomum depile Müll.Hal., *Genera Musc. Frond.* 147 (1901)

T: Vic., *F.M.Campbell 511*; holo: BM.

This is a probably a species of *Bryum s. lat.* (Hyvönen, 1987).

RHIZOGONIACEAE

Scott R. Gilmore[1]

Rhizogoniaceae Broth., *Nat. Pflanzenfam.* I, 3: 614 (1904).

Type: *Rhizogonium* Brid.

Dioicous, synoicous or monoicous. Plants minute to very large, lax to densely tufted. Stems usually simple, sometimes branched or dendroid. Rhizoids ±papillose. Leaves imbricate to widely spaced, erect-spreading to squarrose, unranked or in ranks of 2 or 4, linear-lanceolate to ovate-lanceolate; margin simple or comprised of elongated cells, ±thickened, entire, dentate, serrate, or with single or paired multicellular teeth; costa strong, ending just below the apex to excurrent, often toothed abaxially; laminal cells usually small and isodiametric, ±thick-walled, smooth. Perichaetia bud-like, basal, lateral or terminal. Calyptra long and thin, usually cucullate. Setae erect, elongate. Capsules erect to cernuous, commonly elongate, often arcuate, short-necked, widest at the mouth; operculum ±rostrate. Peristome usually double and well developed. Spores small, globose or ovoid.

Rhizogoniaceae comprises eight genera and about 45 species. It is especially diverse in tropical and subtropical regions of the Southern Hemisphere where it grows on bark and decaying wood in moist habitats, also occurring less commonly on rock and soil. Six genera and 15 species are known from near the east coast of Australia.

The family has gametophytic affinities with the Bartramiaceae and Calomniaceae, and the sporophyte shows similarity to Mniaceae. Rhizogoniaceae is accepted here in its traditional sense; however, it is likely that future research will result in the segregation of new families.

G.O.K.Sainsbury, Notes on Tasmanian mosses from Rodway's herbarium: IV, *Pap. & Proc. Roy. Soc. Tasmania* 89: 21–23 (1955); M.G.Manuel, Synopsis of Rhizogoniaceae Broth. in Malaya, *Cryptog. Bryol. Lichénol.* 2: 449–455 (1981); T.Koponen, A.Touw & D.H.Norris, Bryophyte flora of the Huon Peninsula, Papua New Guinea. XIV. Rhizogoniaceae (Musci), *Acta Bot. Fenn.* 133: 1–24 (1986); A.Eddy, Rhizogoniaceae, *Handb. Malesian Mosses* 3: 197–214 (1996).

KEY TO GENERA

1 Peristome single (exostome lacking); costa ending below the long hairpointed leaf apex .... **2. HYMENODON**

1: Peristome double; costa usually percurrent to excurrent (ending below apex in *Goniobryum*); leaf apex lacking a long hairpoint 2

2 Laminal cells more than 30 µm long *(1:)* .... **1. GONIOBRYUM**

2: Laminal cells less than 30 µm long 3

3 Marginal teeth paired *(2:)* .... **5. PYRRHOBRYUM**

3: Marginal teeth single 4

4 Leaves neither ranked nor complanate, often with propagula between leaves *(3:)* ..... **3. LEPTOTHECA**

4: Leaves ranked and complanate, lacking propagula between leaves 5

5 Leaves 4-ranked; plants 2.5–8.0 cm long; leaf border composed of elongate cells *(4:)* .... **4. MESOCHAETE**

5: Leaves 2-ranked; plants 1–3 cm long; leaf border with or without elongate cells .... **6. RHIZOGONIUM**

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1. GONIOBRYUM

Goniobryum Lindb., *Öfvers. Förh. Kongl. Svenska Vetensk.-Akad.* 21: 606 (1865); from the Greek *gonion* (referring to the sporophyte) and *bryon* (a moss).

Type: *G. subbasilare* (Hook.) Lindb.

Monoicous. Plants tufted, bright green to yellow-green above, brown below. Stems simple to fastigiately branched, tomentose and somewhat matted below. Rhizoids weakly papillose, especially on large stems, red-pink. Propagula absent. Leaves complanate, rarely 2- or 3-ranked, erect-spreading, twisted when dry, oblong to linear-lanceolate, widest at mid-leaf; apex acuminate; margin singly or doubly toothed; costa narrow, ending below apex; laminal cells large, lax. Perichaetia basal in rhizoids. Calyptra elongate, thin, entire at base. Capsules cernuous, long-cylindrical, widest at mouth, often arcuate; operculum bluntly rostrate; exothecal cells rectangular to isodiametric, with uniformly thin cell walls. Peristome double; endostome c. half the length of the exostome. Spores smooth, globose. Chromosome number not known.

Goniobryum is a monotypic genus found throughout the Southern Hemisphere.

H.N.Dixon, Notulae bryologicae, *J. Bot.* 1937: 123 (1937).

Goniobryum subbasilare (Hook.) Lindb., *Öfvers. Förh. Kongl. Svenska Vetensk.-Akad.* 21: 607 (1865)

Hypnum subbasilare Hook., *Musci Exot.* t. 10 (1818); *Rhizogonium subbasilare* (Hook.) Schimp., *Bot. Zeitung (Berlin)* 5: 803 (1847); *Trachyloma subbasilare* (Hook.) Mitt., *J. Proc. Linn. Soc., Bot.* 4: 86 (1860). T: Staten Is., near Cape Horn, *A.Menzies 24*; holo: BM.

Photinophyllum pellucidum Mitt., *J. Linn. Soc., Bot.* 10: 175 (1868); *Rhizogonium pellucidum* (Mitt.) A.Jaeger, *Ber. Tatigk. St. Gallischen Naturwiss. Ges.* 1873–74: 221 (1875); *Goniobryum pellucidum* (Mitt.) Broth., *Nat. Pflanzenfam.* I, 3: 621 (1904). T: ‘Western Rivulet’, Tas., *W.Archer*; syn: NY *n.v.*; Australia, *F.Mueller n.v.*; New Zealand, *C.Knight 139*; syn: BM.

Rhizogonium reticulatum Hampe, *Linnaea* 30: 636 (1860). T: Apollo Bay, [Vic.]; *n.v.*

Illustration: G.A.M.Scott & I.G.Stone, *The Mosses of Southern Australia* 319, pl. 58 (1976).

Plants tufted. Stems 10–45 mm tall, yellow-green to dark brown-red. Leaves oblong to linear-lanceolate, acuminate, 2.2–3.2 mm long, 0.5–1.0 mm wide; upper laminal cells long-hexagonal to rhomboidal, 30–120 × 14–25 µm; basal cells rectangular, 95–165 × 14–25 µm. Perichaetial bracts broadly ovate, tapering to a hairpoint. Setae to 3 cm long, smooth, ±slightly twisted below capsule. Exostome teeth trabeculate, triangular-lanceolate, papillose; endostome with 2 or 3 papillose cilia. Spores 9–16 µm diam.

The species occurs in south-eastern N.S.W., Vic., and Tas.; also known from New Zealand, the Pacific islands and South America. Grows in moist areas on soil, wood, tree ferns and, rarely, on rocks. Map 210.

N.S.W.: Macquarie Rd, *H.Streimann 48927* [*Musci Australas. Exsicc.* 72] (CANB); Monga, 20 km SE of Braidwood, *H.Streimann 5139* (CANB). Vic.: Results Ck, *H.Streimann 36533* (CANB); Sassafras Ck, *H.Streimann 39910* (CANB). Tas.: Upper Browns R., *A.V.Ratkowsky H244* (CANB).

This species can be readily identified by the spotted appearance of its dry or recently wetted leaves due to the aggregation of chloroplasts at either end of the laminal cells. Cells at the edge of the leaves are thinner than other laminal cells, but they do not form a distinct border. The calyptra is very long (c. 2 mm), has an entire base and usually a thin, tubular structure; however, it can sometimes form a bubble-like base.

2. HYMENODON

Hymenodon Hook.f. & Wilson, *London J. Bot.* 3: 548 (1844); from the Greek *humen* (very thin) and *odon* (a tooth), probably in reference to the long, thin endostome processes.

Type: *H. pilifer* Hook.f. & Wilson

Diocious. Plants slightly to densely tufted, yellow-green to pale green. Stem simple. Rhizoids confined to basal part of stem, orange-brown, papillose. Propagula absent. Leaves well spaced on stem, unranked, spreading when dry, oblong; apex rounded to obtuse, with an abrupt hairpoint; margin crenulate; costa ending below the apex or excurrent (not in Australia); laminal cells small, isodiametric. Perichaetia basal. Calyptra not seen. Capsules inclined, ovoid; operculum conical, umbonate, with the apex turned to one side; exothecal cells irregular. Peristome single; exostome lacking. Spores smooth, globose.

A genus of eight species; one in Australia.

Hymenodon pilifer Hook.f. & Wilson, *London J. Bot.* 3: 548 (1844)

T: banks of Huon R., Van Diemen's Land [Tas.], *J.D.Hooker*; syn: BM *n.v.*; New Zealand, syn: BM? *n.v.*

Illustrations: G.O.K.Sainsbury, *Bull. Roy. Soc. New Zealand* 5: 291, pl. 43 (1955); G.A.M.Scott & I.G.Stone, *The Mosses of Southern Australia* 321, pl. 59 (1976).

Stems c. 10 mm long. Leaves unranked, but occasionally appearing 2-ranked, often curled to one side, oblong, 0.57–0.91 mm long (not including hairpoint), 0.23–0.34 mm wide, rounded at the base and apex; apex with a long hairpoint (c. 330–480 µm); margin plane, crenulate (occasionally entire below); costa strong, ending just below apex; laminal cells isodiametric, 5–10 µm wide, mammillose, incrassate. Perichaetia in basal leaf tomentum; leaves lanceolate, c. 0.43 mm long and 0.23 mm wide; apex acuminate; margin plane, entire; costa distinct, ending below the apex; laminal cells elongate, irregular in shape, smooth, 20–72 × c. 10 µm. Setae 10–15 mm long, arising from basal tomentum. Capsules oblong; exothecal cells irregularly isodiametric, incrassate, 10–30 µm wide. Endostome of 16 long thin gradually tapering process c. 300 × 40 µm. Spores 12–16 µm diam. Plate 47.

This moss is most common on tree ferns in moist situations in N.S.W., Vic. and Tas.; also found throughout New Zealand. It has also been reported from Qld (I.G.Stone, *Austrobaileya* 1: 515, 1982), but I have not seen any specimens to confirm this. Map 211.

N.S.W.: Feagons Ck, Budawang Natl Park, 18 km E of Braidwood, *H.Streimann 37989* (CANB). Vic.: Binns Rd, 8 km WNW of Apollo Bay, *H.Streimann 42700* (CANB). Tas.: D'Entrecasteau Channel, *L.Rodway* (CANB).

At first glance, *Hymenodon* is most likely to be mistaken for a *Rhizogonium* or *Leptotheca*, but microscopical examination readily distinguishes the costa ending below the long, hairpointed leaf apex. Male plants are said to be small and growing on the tomentum (Sainsbury, 1955; Scott & Stone, 1976).

3. LEPTOTHECA

Leptotheca Schwägr., *Sp. Musc. Frond.*, Suppl. 2, 1: 135 (1824); from the Greek *leptos* (fine and thin), and the Latin *theca* (a capsule), presumably referring to the long, thin capsules of the genus.

Type: *L. gaudichaudii* Schwägr.

Dioicous. Plants densely tufted, varying greatly in colour, from yellow to dark green. Stems simple, tomentose in lower half. Rhizoids papillose on larger segments, dark brown. Propagula common in upper stem between leaves, filamentous, red-brown. Leaves unranked, not complanate, imbricate, erect-spreading, curled and often twisted when dry, linear-lanceolate to ovate-lanceolate, acuminate to obtuse; margin plane, denticulate or serrate with single teeth; costa percurrent to excurrent, often serrate dorsally in upper half; laminal cells small, isodiametric. Perichaetia terminal. Calyptra cucullate. Capsules erect to horizontal, long-cylindrical; exothecal cells short- to long-rectangular; operculum domed to bluntly

rostrate. Peristome double; endostome segments slightly shorter then exostome teeth. Spores globose, papillose.

A genus of two species, with one species and its two varieties occurring in Australia. Previously, *Leptotheca* was placed in the Aulacomniaceae, but Churchill & Buck (1982) transferred it to the Rhizogoniaceae based on the chromosome number, peristome morphology, laminal cell type and the excurrent, dorsally-toothed costa.

S.P.Churchill & W.R.Buck, A taxonomic investigation of *Leptotheca* (Rhizogoniaceae), *Brittonia* 34: 1–11 (1982).

Leptotheca gaudichaudii Schwägr., *Sp. Musc. Frond.*, Suppl. 2, 1: 135 (1824)

Bryum gaudichaudii (Schwägr.) Spreng., *Syst. Veg.* 4(1): 212 (1827); *Aulocomnium gaudichaudii* (Schwägr.) Mitt., *Hooker's J. Bot. Kew Gard. Misc.* 8: 262 (1856). T: Port Jackson, [N.S.W.], *Gaudichaud*, holo: G *n.v. fide* S.P.Churchill & W.R.Buck, *Brittonia*, 34: 5 (1982); iso: BM.

Leptotheca beccarii Müll.Hal., *Genera Musc. Frond.* 148 (1901). T: Mt Wellington, [Tas.], *Beccari*, lecto: PL *n.v.*, *fide* S.P.Churchill & W.R.Buck, *loc. cit.*; isolecto: NY.

Weissia leptocarpa Schwägr., *in* Gaudichaud, *in* Freycinet, *Voy. Uranie, Bot.* 225 (1828). T: G-HEDW? *n.v.*

Plants tufted. Stems pale green to brown, to 30 mm tall, often with propagula in the upper stem. Leaves curled, slightly twisted and folded along the costa when dry, widest just below mid-leaf; laminal cells 6–12 µm. Inner perichaetial bracts ovate, with a tapering hairpoint; outer bracts linear-lanceolate. Calyptra long and cylindrical. Setae c. 20 mm long. Capsules long-cylindrical, c. 4 mm long, with wide furrows forming distinct vertical parallel ridges. Endostome basal membrane 25–33% the length of the exostome, with 2 papillose cilia. Spores 10–14 µm diam. n = 10, 20, *fide* H.P.Ramsay, *Austral. J. Bot.* 22: 316 (1974).

This species is characterised by the propagula which are very commonly found in the upper stem. The leaves are slightly asymmetrical as the junction of the upper leaf margin to the costa is usually uneven on either side of the costa.

Two varieties are recognised.

Leaves ovate-lanceolate; costa distinctly excurrent .... **a.** var. **gaudichaudii**
Leaves oval; costa percurrent to slightly excurrent .... **b.** var. **wattsii**

a. Leptotheca gaudichaudii Schwägr. var. **gaudichaudii**

Illustration: G.O.K.Sainsbury, *Bull. Roy. Soc. New Zealand* 5: 283, pl. 41 (1955).

Leaves ovate-lanceolate, with an acuminate to obtuse apex, 0.63–1.50 mm long, 0.23–0.48 mm wide; costa distinctly excurrent. Plate 48.

This variety is commonly found on tree bases, dead timber, tree ferns, rocks and soil in Qld, N.S.W., A.C.T., Vic. and Tas. It also occurs in New Zealand, southern Africa and southern South America. Map 212.

Qld: Paling Yard Ck, 21 km ESE of Stanthorpe, *H.Streimann 52965* (CANB). N.S.W.: near Nerriga, *D.McVean 2674112* (CANB). A.C.T.: Little Collins Ck, *H.Streimann 5270* (CANB). Vic.: Mt Zero, *H.Streimann 2601* (CANB). Tas.: Horseshoe Falls, *J.A.Curnow 2596* (CANB).

b. Leptotheca gaudichaudii var. **wattsii** (Cardot) S.P.Churchill & W.R.Buck, *Brittonia* 34: 9 (1982)

Leptotheca wattsii Cardot, *Wiss. Ergebn. Schwed. Südpolar Exped.* 4(8): 146 (1908). T: Mt Wellington, [Tas.], *W.Watts*; holo: PC *n.v.*; iso: BM, NY *n.v.*, *fide* S.P.Churchill & W.R.Buck, *loc. cit.*

Illustrations: S.P.Churchill & W.R.Buck, *op. cit.* 7, figs 17 & 18 (1982).

Leaves oval; apex acute; costa percurrent to slightly excurrent.

This variety is found only in Tas. Map 213.

It was not possible to examine specimens, and the description is based on the observations of Churchill & Buck (1982).

4. MESOCHAETE

Mesochaete Lindb., *J. Linn. Soc., Bot.* 11: 463 (1870); from the Greek *mesos* (middle) and *chaite* (a hair).

Type: *M. undulata* Lindb.

Dioicous. Plants large to very large, to 8 cm long, often forming small mats, yellow-green to olive-green. Stems thick, rigid, sparingly branched, tomentose at the base. Rhizoids smooth, orange-brown. Propagula absent. Leaves complanate, 4-ranked, crisped when dry, asymmetrical; margin distinct, thickened, with single multicellular teeth towards apex; costa strong, excurrent, dividing leaf unevenly; upper laminal cells small, isodiametric; most basal cells more elongate. Perichaetia in leaf axils. Calyptra not seen. Capsules elongate, arcuate, broadly sulcate. Peristome double. Spores globose, smooth.

This endemic genus of two species is found in moist habitats along the east coast of Australia.

Mesochaete is distinctive due to the large size of the plants and the 4-ranked, complanate leaf arrangement.

I.G.Stone, A re-evaluation of the species of *Mesochaete* Lindb. (Rhizogoniaceae), *J. Bryol.* 12: 351–357 (1983).

Plants very large, to 8 cm long; laminal cells 12–30 µm wide .... **1. M. taxiforme**

Plants large, to 5 cm long; laminal cells 8–13 µm wide .... **2. M. undulata**

1. Mesochaete taxiforme (Hampe) Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 150 (1906)

Rhizogonium taxiforme Hampe, *Linnaea* 40: 313 (1876). T: Johnstone R., [Qld], *W.Hill 293*; holo: B? (destroyed?); iso: BM *n.v.*, *fide* I.G.Stone, *J. Bryol.* 12: 357 (1983).

Mesochaete grandiretis Dixon, *Proc. Roy. Soc. Queensland* 53(2): 31 (1942). T: Platypus Ck, Cairns, Qld, 3 Jan. 1936, *H.Flecker 1225*; holo: BM; iso: CANB. Baron Gorge, Kuranda, Qld, 3 July 1936, *S.Egan 1932*; para: BM, BRI; Burrows Ck, Cairns, Qld, 21 Sept. 1936, *H.Flecker 2351* (*2551* in Dixon, *Proc. Roy. Soc. Queensland* 53: 31, 1942); para: BM.

Illustrations: I.G.Stone, *op. cit.* 353, fig. 1; facing page 354, pl. 1a–e; 355, fig. 2i–l.

Plants very large, to 8 cm long. Stems simple to sparingly branched, reddish at base, yellow-green above. Leaves large, erect-spreading, 3.4–6.0 mm long, 1.5–2.7 mm wide; apex rounded to acute; margin of distinct very elongated cells with multicellular teeth in the upper third of the leaf; costal cells c. 12 µm wide; laminal cells isodiametric, 12–30 µm. Perichaetial bracts triangular-lanceolate; costa strong, ending just below the apex to percurrent; marginal cells with a thickened outer wall, entire to denticulate. Sporophyte not seen.

Found on soil in moist, shaded areas north of Townsville, north-eastern Qld. Map 214.

Qld: Mt Misery, *M.M.J. van Balgooy 1618* (CANB); Blue Water Ck, *H.Streimann 28414* (CANB); Mt Lewis, *D.H.Norris 41672* (CANB).

2. Mesochaete undulata Lindb., *Öfvers Förh. Kongl. Svenska Vetensk.-Akad.* 12: 70 (1870); *J. Linn. Soc., Bot.* 11: 463 (1870)

Mnium undulatum (Lindb.) Müll.Hal., *Genera Musc. Frond.* 143 (1901); *Rhizogonium undulatum* (Lindb.) A.Jaeger, *Ber. Tätigk. St. Gallischen Naturwiss. Ges.* 1873–74: 224 (1875). T: New England, [N.S.W.], *F.Mueller*; syn?: NSW *n.v.*, *fide* I.G.Stone, *J. Bryol.* 12: 357 (1983).

Rhizogonium plumaeforme Hampe, *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 148 (1906). T: Rockingham’s Bay, Qld, *W.Kellaway*; syn?: MEL *n.v.*

Illustrations: G.A.M.Scott & I.G.Stone, *The Mosses of Southern Australia* 323, pl. 60 (1976); I.G.Stone, *J.Bryol.* 12: facing page 354, pl. 1f; 355, fig. 2a–h (1983).

Plants large, to 5 cm long. Stems simple to sparingly branched, red at the base, yellow-green above. Leaves large, imbricate, erect-spreading, rounded to bluntly acute, 1.8–4.5 mm long,

0.6–1.8 mm wide; margin of distinct very elongated cells with multicellular teeth more than half-way down leaf on one side; costal cells c. 7 µm wide; laminal cells isodiametric, 8–13 µm. Perichaetial bracts lanceolate; marginal cells with a heavily thickened outer wall, denticulate; costa percurrent. Setae pale brown, 15–35 mm long. Capsules erect, elongate, cylindrical, c. 5 mm long; operculum bluntly rostrate. Peristome papillose. Spores 8–9 µm. *n* =10, *fide* H.P.Ramsay, *Austral. J. Bot.* 22: 316 (1974). Plate 49.

This species is found in coastal areas of southern Qld, N.S.W. and Vic.; usually on rocks or on soil beside streams. Map 215.

Qld: "Natural Bridge", Cave Ck, *H.Streimann 6011* (CANB). N.S.W.: Richmond River State Forest, *H.Streimann 7049* (CANB); O'Sullivans Gap Nature Reserve, *H.Streimann 51994* (CANB). Vic.: Genoa River Gorge, *J.H.Willis s.n.* (MELB).

5. PYRRHOBRYUM

Pyrrhobryum Mitt., *J. Linn. Soc., Bot.* 10: 174 (1868); from the Greek *pyrros* (red) and the *bryon* (a moss), presumably in reference to the reddish colour of the capsule mouth.

Type: *P. spiniforme* (Hedw.) Mitt.

Synoicous or dioicous. Lax to densely tufted in moist conditions, usually olive-green. Stems short to long, tomentose in lower half or only at the base. Rhizoids red-brown, smooth or rarely lightly papillose. Propagula absent. Leaves mostly unranked, characteristically curled and twisted when dry, erect-spreading to squarrose, linear-lanceolate, lanceolate or oblong, acute to acuminate; margins bistratose, with paired teeth; costa strong, percurrent to excurrent, not always cutting leaf evenly, toothed abaxially; laminal cells small, isodiametric. Perichaetia on a short stem, attached to lower part of stem or basal. Calyptra cucullate. Capsules erect to horizontal, cylindrical to pyriform, arcuate; exothecal cells hexagonal; operculum rostrate and curled to one side. Peristome double; endostome c. half the length of the exostome. Spores smooth, globose.

Six of the ten species of *Pyrrhobryum* are known from Australia where they are found in moist areas along the east coast.

This genus is readily recognised by its long leaves and paired teeth. However, separation of some of the species can be very difficult, especially in the absence of perichaetial bracts. The *P. spiniforme* complex is particularly problematic and is in need of a comprehensive revision. *Pyrrhobryum spiniforme*, *P. paramattense* and *P. latifolium* are all very similar and, possibly, conspecific.

1 Stems dendroid; branch leaves in 2 ranks .... **1. P. bifarium**

1: Stems simple or rarely branched, never dendroid; leaves not ranked........ 2

  2 Plants minute, less than 15 mm tall; upper stem leaves planar and dimorphic *(1:)* ....**3. P. medium**

  2: Plants larger, more than 15 mm tall; upper stem leaves not planar or dimorphic 3

3 Leaves strongly curled and twisted when dry; leaf size not varying greatly along stem; perigonia and perichaetia lateral; stems tomentose on lower half to one-third *(2:)*........ **4. P. mnioides**

3: Leaves curved but not markedly twisted when dry; leaf size very different along stem; perigonia and perichaetia basal; stems tomentose only at the base 4

  4 Inner perichaetial bracts with an ovate base, abruptly tapering to a narrow apex; bract margins singly serrate *(3:)*........ **6. P. spiniforme**

  4: Inner perichaetial bracts with a lanceolate base, gradually tapering to a narrow apex; bract margins singly or doubly serrate 5

5 Leaves distinctly widest at their mid-point *(4:)*........**2. P. latifolium**

5: Leaves widest at or near the base........**5. P. paramattense**

1. Pyrrhobryum bifarium (Hook.) Manuel, *Cryptog., Bryol. Lichénol.* 1: 70 (1980)

Hypnum bifarium Hook., *Musci Exot.* 1: 57 (1818); *Rhizogonium bifarium* (Hook.) Schimp., *Bot. Zeitung (Berlin)* 5: 803 (1847); *Mnium bifarium* (Hook.) Müll.Hal., *Syn. Musc. Frond.* 1: 172 (1848). T: "Dusky Bay" [Dusky Sound], New Zealand, 1791, *A.Menzies 87*; holo: BM.

Illustrations: G.O.K.Sainsbury, *Bull. Roy. Soc. New Zealand* 5: 296, pl. 44 (1955), as *Rhizogonium bifarium*; G.A.M.Scott & I.G.Stone, *The Mosses of Southern Australia* 310, pl. 54 (1976), as *Rhizogonium bifarium*; J.Beever, K.W.Allison & J.Child, *Mosses of New Zealand*, 2nd edn 102, fig. 45a–d (1992).

Dioicous. Plants densely tufted, pale green to olive-green. Stems dendroid, c. 15 mm tall, tomentose at the base. Branches with distichous leaves; stems with unranked leaves. Leaves erect-spreading, often curled when dry, lanceolate to oblong-lanceolate, acute, 1–2 mm long, 0.3–0.6 mm wide; costa percurrent to short-excurrent; laminal cells irregularly shaped throughout, 7–16 µm wide. Perigonia and perichaetia axillary on primary stem. Perichaetial bracts ovate to lanceolate, with a thin tapering apex; inner perichaetial bracts with a finer and more tapered apex; margin entire; laminal cells elongate and thin-walled below, similar to vegetative leaf cells above. Setae c. 20 mm long. Capsules pyriform. Endostome with 1 cilium per segment. Spores 18–22 µm.

Occurs in moist habitats in south-eastern N.S.W. and Tas.; grows on wood, rock or soil. Also in New Zealand and SE Asia. Map 216.

N.S.W.: Macquarie Pass Natl Park, *H.Streimann 53089* (CANB). Tas.: Mt Wellington, *A.V.Ratkowsky H46* (CANB); Hobart Rivulet, 15 Dec. 1888, *W.A.Weymouth s.n.* (CANB).

This moss is readily distinguished from other Australian *Pyrrhobryum* species by its dendroid habit and distichous branch leaves.

2. Pyrrhobryum latifolium (Bosch & Sande Lac.) Mitt., *J. Linn. Soc., Bot.* 10: 175 (1868)

Rhizogonium latifolium Bosch & Sande Lac., *Bryol. Javan.* 2, t. 133 (1861). T: "Habitat insulam Banca", [Indonesia]; syn: BR; Banca; syn: SOL, *fide* T.Koponen *et al.*, *Acta Bot. Fenn.* 133: 14 (1986).

Illustration: A.Eddy, *Handb. Malesian Mosses*. 3: 208, fig. 473 (1996).

Dioicous. Plants loosely tufted, green to olive-green. Stems simple, c. 20 mm tall, tomentose only at the very base. Leaves unranked, wide-spreading, slightly curled and twisted when dry, lanceolate to oblong, often falcate, tapering at the base, 1.7–4.2 mm long, 0.3–0.5 mm wide, distinctly widest at mid-leaf, acuminate; costa percurrent; laminal cells irregularly shaped throughout, rarely subquadrate below, 7–12 µm wide. Perigonia and perichaetia basal. Outer perichaetial bracts with an oblong base and abruptly tapering to an acute apex, or with a lanceolate base and tapering more gradually to an acuminate apex; inner bracts with a lanceolate base, gradually tapering to a long thin apex; margin with single or paired teeth; basal cells elongate, thin-walled; apical cells identical to those of the vegetative leaf lamina. Setae to 35 mm tall. Capsules elongate, cylindrical. Endostome with 3 (rarely 2) papillose cilia per segment. Spores 13–18 µm.

Pyrrhobryum latifolium is reported here for the first time from Australia. It grows on wood in moist areas in eastern Qld; also throughout Malesia. Map 217.

Qld: Moho Ck, *H.Streimann 16926* (CANB); Credition State Forest, *H.Streimann 37659* (CANB); Dawes Ra., *H.Streimann 52465* (CANB); Mt Misery, *H.Streimann* 57479 (CANB).

This species is very similar to *P. paramattense* and *P. spiniforme*, with leaf size varying greatly along the stem, basal perigonia and perichaetia, and rhizoids only at the very base of the stem. It differs by having leaves that are broader in the mid-leaf than at the base.

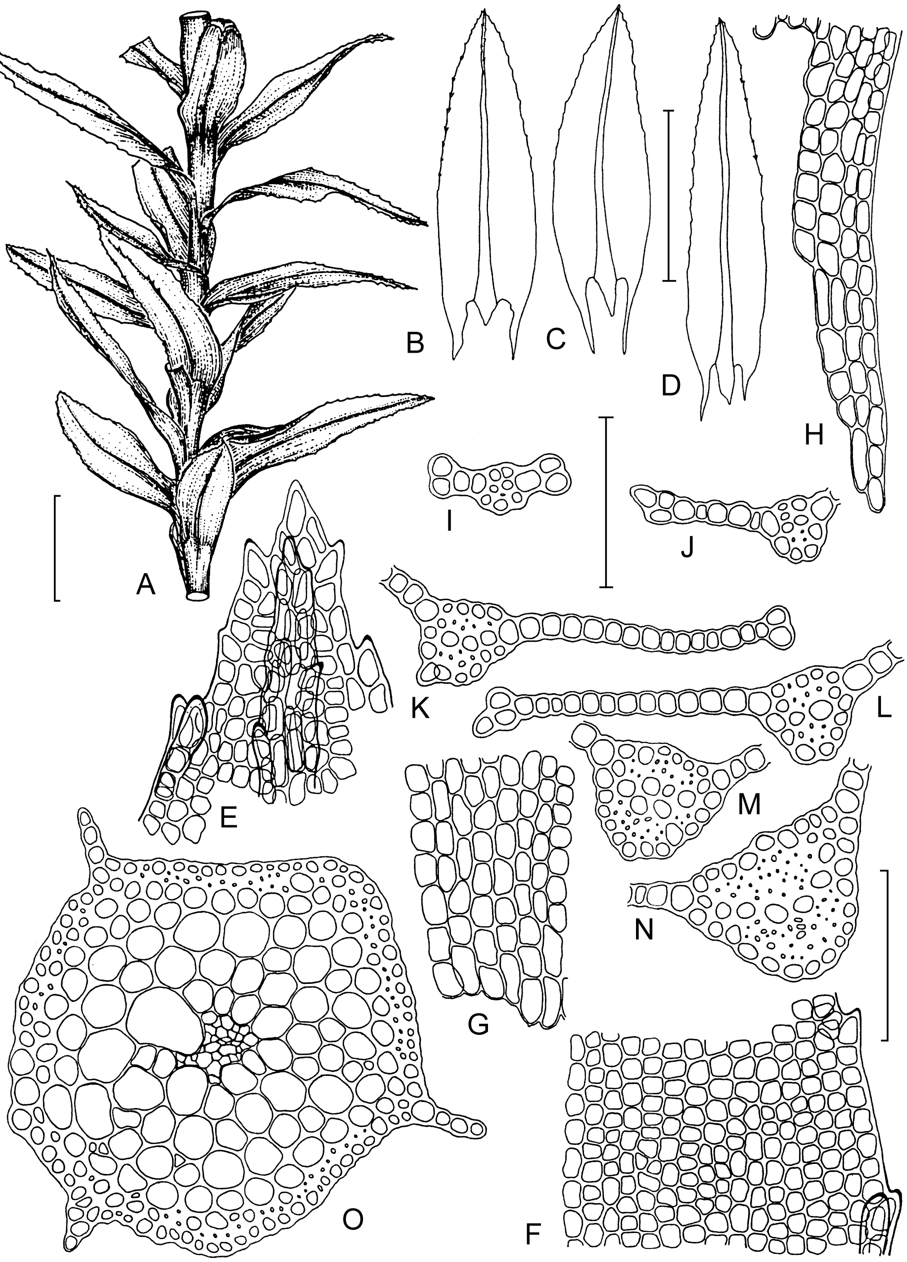

Figure 52. *Pyrrhobryum mnioides*. **A**, Habit of stem segment, showing strongly decurrent leaves; **B–D**, Leaves; **E**, Cells of leaf apex; **F**, Mid-laminal cells and twinned marginal teeth; **G**, Laminal cells at leaf base; **H**, Cells of basal angle of leaf; **I–N**, Costal and leaf sections; **O**, Stem section. Scale bars: 1 mm for plant and leaves; 100 µm for cells and sections. Drawn by R.D.Seppelt. Reproduced from *The Moss Flora of Macquarie Island* 249 (2004).

3. Pyrrhobryum medium (Besch.) Manuel, *Cryptog., Bryol. Lichénol.* 1: 69 (1980)

Rhizogonium medium Besch., *Ann. Sci. Nat. Bot.*, sér. 5, 13: 217 (1873). T: Île des Pins, New Caledonia, *Pancher*; holo: BM *n.v.*, *fide* N.Bell. (pers. comm.).

Rhizogonium brevifolium Broth., *Oefvers Förh. Finska Vetensk.-Soc.* 33: 102 (1891); *Mnium brevifolium* (Broth.) Müll.Hal., *Genera Musc. Frond.* 140 (1901); *Pyrrhobryum brevifolium* (Broth.) Manuel, *Cryptog., Bryol. Lichénol.* 1: 69 (1980). T: Bellenden Ker Ra., Qld, *F.M.Bailey 621, 653*; syn: H-BR *n.v*, BM.

Illustration: T.Koponen, A.Touw & D.H.Norris, *Acta Bot. Fenn.* 133: 18, fig. 9 (1986).

Dioicous. Plants small, slightly tufted, dull olive-green. Stems simple, to 15 mm tall, tomentose only at the very base. Leaves unranked, but often appearing 3- or 4-ranked at the apex. Basal leaves small, spreading, lanceolate and slightly tapered at the base; costa percurrent; laminal cells isodiametric, c. 6–7 µm. Leaves higher on the stem becoming larger, planar and dimorphic. Dorsal row of leaves oblong-lanceolate, asymmetrical, 1.3–2.1 mm long, 0.2–0.5 mm wide, widest in mid-leaf; costa percurrent to slightly excurrent, arcuate. Ventral row (or rows) of leaves similar to basal leaves, lanceolate, symmetrical, 0.87–1.35 mm long, 0.11–0.30 mm wide, widest just above leaf base; costa percurrent to short-excurrent; laminal cells isodiametric, 5–11 µm. Perigonia and perichaetia basal. Outer perichaetial bracts broadly triangular-lanceolate to lanceolate; inner perichaetial bracts from an ovate or oblong base and gradually tapering to a long thin apex; margin with single or paired serration; basal cells long-hexagonal, thin-walled; upper cells like those of the vegetative leaves, but more often with elongate (rectangular) cells. Sporophyte not seen. $n = 6$, *fide* H.P.Ramsay, *Austral. J. Bot.* 22: 316 (1974), as *R. brevifolium*.

Uncommon on moist wood and tree ferns in north-eastern Qld; also in Borneo and New Guinea and in the Pacific east to French Polynesia. Map 218.

Qld: Crater State Forest, Hugh Nelson Ra., *H.Streimann 27064* (CANB); Mt Misery, *H.Streimann 57377, 57406, 57414* (CANB); Paluma Reservoir road, *H.Streimann 57824* (CANB).

There is often a marked difference between the two leaf types in Australian material, with plants often appearing very like *Calomnion* (Calomniaceae) in having 3-ranked, dimorphic leaves. However, in other Australian collections the planar leaf arrangement and dimorphic leaves are less obvious.

4. Pyrrhobryum mnioides (Hook.) Manuel, *Cryptog., Bryol. Lichénol.* 1: 70 (1980)

Hypnum mnioides Hook., *Musci Exot.* 1: 57, t. 77 (1818); *Rhizogonium mnioides* (Hook.) Wilson, *in* J.D.Hooker, *Fl. Nov.-Zel.* 2: 116 (‘1855’) [1854]. T: Staten Is., near Cape Horn, *A.Menzies 17*; holo: BM *n.v.*

Rhizogonium mnioides (Hook.) Wilson var. *contortum* Wilson, *in* J.D.Hooker, *Fl. Tasman.* 2: 216 (1859). T: Mt Wellington, [Tas.], *S.Mossman*; syn: BM? *n.v.*; Browns R., Back River Gully, [Tas.], *A.F.Oldfield 114, 326*; syn: BM *n.v*.

Rhizogonium mnioides (Hook.) Wilson var. *lutescens* Wilson, *in* J.D.Hooker, *Fl. Tasman.* 2: 216 (1859). T: “Western Mtns”, [Tas.], *R.C.Gunn 1612*; holo: BM? *n.v.*

Mnium hookeri Müll.Hal., *Syn. Musc. Frond.* 2: 555 (1851); *Rhizogonium hookeri* (Müll.Hal.) Mitt., *J. Proc. Linn. Soc., Bot*. 4: 95 (1860). T: Auckland Islands, *J.D.Hooker*; holo: BM? *n.v.*

Mnium mossmanianum Müll.Hal., *Bot. Zeitung (Berlin)* 9: 547 (1851); *Rhizogonium mossmanianum* (Müll.Hal.) A.Jaeger, *Ber. Tätigk. St. Gallischen Naturwiss. Ges.* 1873–74: 221 (1875). T: Mt Wellington, Tas., *S.Mossman 753*; holo: B? *n.v.* (probably destroyed).

Polytrichum gullweri Hampe, *Linnaea* 40: 315. (1876); *Pogonatum gullweri* (Hampe) A.Jaeger, *Ber. Tätigk. St. Gallischen Naturwiss. Ges.* 1877–78: 453 (1879). T: Mt Wellington, Tas., *J. & B.Gullifer s.n.*; holo: BM. [commonly misspelled “*gulliveri*”].

Illustrations: G.O.K.Sainsbury, *Bull. Roy. Soc. New Zealand* 5: 296, pl. 44 (1955), as *Rhizogonium mnoides*; G.A.M.Scott & I.G.Stone, *The Mosses of Southern Australia* 315, pl. 56 (1976), as *Rhizogonium mnoides*; R.D.Seppelt, *The Moss Flora of Macquarie Island* 249, fig. 97 (2004).

Dioicous. Plants tufted, pale green to dull olive-green. Stems to 5 cm tall, tomentose on the lower 33–50%. Leaves unranked, strongly curled and twisted when dry, wide-spreading, linear-lanceolate, acuminate, 1.6–4.0 mm long, 0.3–0.8 mm wide; costa percurrent; upper laminal cells irregular in shape, 8–14 µm; basal cells subquadrate to short-rectangular. Perichaetia and perigonia lateral in lower half of stem. Outer perichaetial bracts short, ovate to

ovate-lanceolate with a short-acute to acuminate apex; inner bracts ovate to lanceolate, with a long and often twisted apex; margin serrate towards the apex; costa percurrent; basal cells thin-walled, greatly elongated; upper cells thick-walled, rectangular. Setae c. 35 mm tall. Capsules horizontal, cylindrical. Endostome with 2 slightly papillose cilia. Spores 18–20 µm. *n* = 12, *fide* H.P.Ramsay, *New Manual of Bryology* 1: 195, 221 (1981). Fig. 52, Plates 50, 51.

Occurs in very moist habitats at higher altitudes in N.S.W., A.C.T., Vic. and Tas.; grows on rock and soil and, less commonly, on wood. Also in New Zealand and South America. Map 219.

N.S.W.: Leatherbarrel Ck, *H.Streimann 1467* (CANB). A.C.T.: head of Gingera Ck, *H.Streimann 4193* (CANB); Brindabella Ra., *H.Streimann 4164* (CANB). Vic.: Results Ck, *H.Streimann* 43688 (CANB). Tas.: The Spring, *A.V.Ratkowsky H51* (CANB).

The leaves vary in size along the stem, but not as much as in other species of *Pyrrhobryum*. *Pyrrhobryum mnioides* is characterised by the appearance of the strongly curled and twisted leaves, the lateral perigonia and perichaetia and the presence of tomentum above the base of the stem.

5. Pyrrhobryum paramattense (Müll.Hal.) Manuel, *Cryptog., Bryol. Lichénol.* 1: 69 (1980)

Mnium paramattense Müll.Hal., *Syn. Musc. Frond.* 2: 555 (1851); *Rhizogonium paramattense* (Müll.Hal.) Reichardt, *Reise Novara, Pilze, Leber-Laubm.* 1(3): 180 (1870). T: Parramatta, [N.S.W.], *Huegel*; holo: B *n.v.* (probably destroyed).

Illustrations: G.A.M.Scott & I.G.Stone, *The Mosses of Southern Australia* 316, pl. 57 (1976), as *Rhizogonium paramattense*; H.Streimann, *The Mosses of Norfolk Island* 139, fig. 62 (2002).

Dioicous. Plants loosely to densely tufted, pale to dark olive-green. Stems simple, to 7 cm long, tomentose only at the extreme base. Leaves unranked, curled and slightly twisted when dry, wide-spreading, linear-lanceolate to triangular-lanceolate, often falcate, widest at the base, acuminate, 3.6–6.0 mm long, 0.3–0.7 mm wide; costa percurrent; basal laminal cells subquadrate; apical cells isodiametric and irregular, 6–12 µm. Perichaetia and perigonia basal. Outer perichaetial bracts ovate and abruptly tapering to acute apex, or triangular-lanceolate; inner bracts lanceolate and gradually tapering to a long thin apex; margin with single or paired serration; basal cells elongate, thin-walled; apical cells identical to those of the leaf lamina or short-rectangular and thick-walled. Setae to 6 cm tall. Capsules elongate, cylindrical to urceolate. Endostome with 3 papillose cilia. Spores 13–18 µm. *n* = 6, *fide* H.P.Ramsay, *Austral. J. Bot.* 22: 316 (1974). Plate 52.

Occurs on wood, rarely on rock, in very moist habitats in eastern Qld, N.S.W. and Vic.; also known from Norfolk Is. and New Zealand. Map 220.

Qld: Fraser Is., *C.Borough 3* (CANB); slopes of Black Mtn, Atherton Tableland, *H.Streimann 31145* (CANB); Credition State Forest, *H.Streimann 37671* (CANB). N.S.W.: Brindle Ck, *H.Streimann 6092* (CANB). Vic.: McKensie R., *H.Streimann 1338* (CANB).

There is a marked difference in leaf size along the stem with the basal leaves greatly reduced, and the longer leaves at the apex giving it a tassel-like appearance. While *P. paramattense* has previously been reported from Tasmania, all Tasmanian specimens examined were *P. mnioides*.

6. Pyrrhobryum spiniforme (Hedw.) Mitt., *J. Linn. Soc., Bot.* 10: 174 (1868)

Hypnum spiniforme Hedw., *Sp. Musc. Frond.* 236 (1801); *Rhizogonium spiniforme* (Hedw.) Bruch, *Flora* 29: 134 (1846). T: Jamaica; holo: G-HEDW *n.v.*

Synoicous or dioicous. Plants loosely to densely tufted, pale to dark olive-green. Stems simple, to 5.5 cm long, tomentose only at the extreme base. Leaves unranked, curled and slightly twisted when dry, wide-spreading, linear-lanceolate to triangular-lanceolate, often falcate, widest in the lower 25–33%, acuminate, 2.5–7.7 mm long, 0.2–1.0 mm wide; costa percurrent; basal laminal cells subquadrate, irregular above, 7–13 µm. Perichaetia and perigonia basal. Outer perichaetial bracts broadly ovate, abruptly tapering to an acute apex; inner bracts ovate, abruptly tapering to a long thin apex; margin singly serrate; basal cells

elongate, thin-walled; cells in apex rectangular, rarely irregular. Setae to 5.5 cm tall. Capsules elongate, cylindrical to urceolate. Endostome with 2 or 3 papillose cilia. Spores 14–18 µm.

Occurs on rock, soil and wood in Qld, N.S.W. and Vic. Widespread in Central and South America, the Hawaiian Is., Africa, SE Asia, Malesia and Lord Howe Is. Map 221.

Qld: Home Rule Falls, *H.Streimann 57013* (CANB); Tozers Gap, *H.Streimann 56428* (CANB). N.S.W.: Middle Ck, *H.Streimann 5720* (CANB); Bodalla State Forest, *H.Streimann 38212* (CANB). Vic.: Ferntree Gully, *Martin s.n.* (MEL).

Pyrrhobryum spiniforme has the same tassel-like apices as are seen in the far more common *P. paramattense*. It has been described as synoicous, but it is more commonly dioicous in Australia.

6. RHIZOGONIUM

Rhizogonium Brid., *Bryol. Univ.* 2: 663 (1827); from the Greek *rhiza* (a root) and *gonion* (referring to the sporophyte); the name refers to the copious paraphyses suggesting a rooted sporophyte, *fide* H.A.Crum & L.E.Anderson, *Mosses of Eastern North America* 2: 657 (1981).

Type: *R. novaehollandiae* (Brid.) Brid.

Dioicous. Plants tufted, yellow to olive-green. Stems short, simple, tomentose at the base. Rhizoids smooth, red-brown. Propagula absent. Leaves complanate, distichous, imbricate, erect-spreading to wide-spreading, often decurrent, ovate to linear-lanceolate; apex acute to acuminate; margin entire to singly toothed, with or without a distinct border; costa strong, ending below apex to excurrent; laminal cells small, isodiametric. Perichaetia basal, often in tomentum. Calyptra cucullate. Capsules inclined to pendulous (rarely erect), cylindrical, conical or urceolate, widest at the mouth; exothecal cells isodiametric; operculum rostrate, short or long, with the apex bent to one side. Peristome double; endostome 33–50% the length of the exostome. Spores globose to ovoid, smooth.

Rhizogonium includes c. 20 species, with many occurring in the wet-tropics. Four species are known from Australia, although three occur mainly in cool-temperate areas.

The genus is similar to elements of *Pyrrhobryum*, with the stem leaves varying from small at the base to larger above.

S.Inoue & Z.Iwatsuki, A cytotaxonomic study of the genus *Rhizogonium* Brid. (Musci), *J. Hattori. Bot. Lab.* 41: 389–403 (1976).

1 Leaves bordered by elongate cells.. **4. R. pennatum**

1: Leaves not bordered by elongate cells.. 2

  2 Costa ending just below the coarsely toothed leaf apex; leaves more than 0.6 mm wide *(1:)* .... **1. R. distichum**

  2: Costa ending below the apex to excurrent; leaf apex not coarsely toothed; leaves less than 0.6 mm wide.. 3

3 Length-width ratio of leaves less than 3: 1; costa excurrent *(2:)*........................ **3. R. novaehollandiae**

3: Length: width ratio of leaves more than 3: 1; costa ending below apex to excurrent.. **2. R. graeffeanum**

1. Rhizogonium distichum (Sw.) Brid., *Bryol. Univ.* 2: 665 (1827)

Hypnum distichum Sw., *J. Bot. (Schrader)* 2: 179 (1801) [3f. A. 1802]; *Mnium distichum* (Sw.) Müll.Hal., *Syn. Musc. Frond.* 1: 173 (1848). T: “Dusky Bay” [Dusky Sound], New Zealand, 1791, *A.Menzies 89*; iso?: BM.

Rhizogonium muelleri Hampe, *Linnaea* 28: 211 (1856). T: Sealers Cove, Vic., *coll. unknown*; holo: BM.

Illustration: J.Beever, K.W.Allison & J.Child, *Mosses of New Zealand*, 2nd edn 102, fig. 45g (1992).

Plants yellow-green to olive-green. Stems c. 10 mm long. Leaves erect-spreading, decurrent, oblong to ovate-lanceolate, 1.5–2.2 mm long, 0.6–1.0 mm wide; margin entire below the coarsely toothed apex; costa ending just below the apex; laminal cells usually hexagonal

above and subquadrate below, thick-walled, 12–19 µm, rarely larger. Perichaetial bracts lanceolate, often with a long tapering twisted hairpoint. Setae to 20 mm long. Capsules inclined to pendulous (rarely erect), cylindrical to urceolate, widest at the mouth, c. 2 mm long; operculum long-rostrate. Exostome covered in small blunt papillae; endostome with 3 papillose cilia per segment. Spores 14–18 µm. Plate 53.

Occurs in N.S.W. south of Port Macquarie and in A.C.T., Vic. and Tas.; grows on tree ferns and fallen or rotting logs. Also known from New Zealand and SE Asia. Map 222.

N.S.W.: Mongarlowe R., *H.Streimann 49025* (CANB). A.C.T.: gully along Warks Rd, *S.R.Gilmore 170* (CANB). Vic.: Mitchell River Natl Park, *H.Streimann 50221* (CANB). Tas.: Tasman Penin., *W.A.Weymouth 1672* (CANB).

Rhizogonium distichum differs from other species by the costa ending below the apex and by lacking elongate cells between the tip of the costa and the tip of the leaf. Although few in number, the teeth on the leaf apex are quite distinctive, consisting of 1–3 cells with a larger, central tooth above the costa.

2. **Rhizogonium graeffeanum** (Müll.Hal.) A.Jaeger, *Ber. Tätigk. St. Gallischen Naturwiss. Ges.* 1873–74: 220 (1875)

Mnium graeffeanum Müll.Hal., *J. Mus. Godeffroy* 3(6): 61 (1874). T: Savai'i, [Western] Samoa, *R.Graeffe*; B? (probably destroyed) *n.v.*

Rhizogonium geheebii Müll.Hal., *Hedwigia* 36: 332 (1897); *Mnium geheebii* (Müll.Hal.) Müll.Hal., *Genera Musc. Frond.* 142 (1901). T: Sydney, N.S.W., 1875, *D.Kayser*; holo: B? (probably destroyed) *n.v.*; iso: BM (two specimens).

Illustration: T.Koponen, A.Touw & D.H.Norris, *Acta Bot. Fenn.* 133: 10, fig. 5f–i (1986).

Plants yellow-green to pale green. Stems to 15 mm long. Leaves wide-spreading, slightly decurrent, linear-lanceolate, rarely oblong-lanceolate, acuminate, 0.85–1.32 mm long, 0.23–0.35 mm wide; margin unevenly dentate in upper half; costa ending just below the apex to percurrent, rarely short-excurrent; laminal cells mostly hexagonal, 11–16 µm wide, thin- or thick-walled. Outer perichaetial bracts lanceolate; inner bracts ovate-lanceolate. Setae to 10 mm long. Capsules erect to cernuous, urceolate to conical, widest at the mouth, to 0.6 mm long; operculum bluntly rostrate. Exostome teeth papillose; endostome with 1 cilium per segment. Spores 9.5–12.0 µm.

This species is found on wood in moist areas of eastern Qld and in N.S.W. as far south as Wyong. Also in New Guinea. Map 223.

Qld: Ravenshoe, *W.W.Watts Q502* (NSW); Nambour, *D.Verdon 5208* (CANB). N.S.W.: Richmond R., *W.W.Watts 3676* (NSW); Kingwell, Wyong, *W.W.Watts s.n.* (NSW).

Sporophytes are uncommon, and the foregoing description is based on only a few specimens. The leaves are often slightly crisped or curled parallel to the costa when dry. *Rhizogonium graffeanum* is distinguished from *R. novaehollandiae* by its narrower leaves.

3. **Rhizogonium novaehollandiae** (Brid.) Brid., *Bryol. Univ*. 2: 664 (1827)

Fissidens novaehollandiae Brid., *Bot. Zeitung (Regensburg)* 1: 212, 234 (1802); *Skitophyllum novaehollandiae* (Brid.) Bach.Pyl., *J. Bot. (Desvaux)*, sér. 2, 4: 165 (1815); *Hypnum novaehollandiae* (Brid.) Arnott, *Mém. Soc. Linn. Paris* 5: 301 (1827); *Mnium novaehollandiae* (Brid.) Müll.Hal., *Syn. Musc. Frond.* 1: 173 (1848). T: "Novae Hollandiae" [Australia], *J.-J.H. de Labillardière*; holo: B? (probably destroyed) *n.v.*

Illustration: J.Beever, K.W.Allison & J.Child, *The Mosses of New Zealand*, 2nd edn 102, fig. 45f (leaf only) (1992).

Plants yellow to olive-green. Stems 10–20 mm long. Leaves crowded to dispersed on the stem, imbricate to erect-spreading, slightly decurrent, ovate, oblong or lanceolate, acute, 0.8–1.5 mm long, 0.4–0.6 mm wide; margin lightly dentate towards apex; costa short-excurrent to excurrent; basal laminal cells subquadrate; upper cells hexagonal, 10–14 µm wide, ±thick walled. Inner perichaetial bracts ovate with a tapering apex; outer bracts triangular-lanceolate. Setae c. 20 mm tall. Capsules cernuous, cylindrical, 1.5–2.0 mm long, usually widest at the mouth; operculum long-rostrate. Exostome teeth papillose; endostome

with 1 papillose cilium per segment. Spores 14.0–16.5 µm. *n* = 5, *fide* H.P.Ramsay, *Austral. J. Bot.* 22: 315 (1974).

Rhizogonium novaehollandiae grows on wood and tree ferns in moist habitats in southern Vic. and Tas.; also in New Zealand and Central and South America. Map 224.

Vic.: Coast Range Rd, *H.Streimann 36683* (CANB). Tas.: Mt Wellington, *W.A.Weymouth 2337* (CANB); King William Saddle, *J.A.Curnow 4411* (CANB).

The two ranks of leaves are commonly folded towards each other when dry.

4. Rhizogonium pennatum Hook.f. & Wilson, *in* J.D.Hooker, *Fl. Nov.-Zel.* 2: 116 (‘1855’) [1854]

var. **aristatum** (Hampe) Dixon, *Bull. New Zealand Inst.* 3: 220 (1926)

Rhizogonium aristatum Hampe, *Linnaea* 40: 314 (1876). T: mountains near L. Pedder, Tas., *Schuster 70*; holo: BM.

Illustration: G.A.M.Scott & I.G.Stone, *The Mosses of Southern Australia* 312, pl. 55 (1976).

Plants pale green to olive-green. Stems to 3 cm long, rarely longer. Leaves wide-spreading to squarrose, slightly decurrent, lanceolate to oblong-lanceolate, rarely triangular-lanceolate, acuminate, 1.4–2.1 mm long, 0.4–0.6 mm wide; margin thickened, composed of elongate cells, entire to serrulate below, serrulate to serrate above (rarely entire); costa strongly excurrent; laminal cells mostly hexagonal, 9–16 µm, thin- or thick-walled. Perichaetial bracts ovate to lanceolate. Setae c. 30 mm long. Capsules cernuous, cylindrical, c. 1.9 mm long; operculum short-rostrate. Peristome and spores not seen.

Rare on rocks and soil in south-eastern N.S.W. (Blue Mountains) and Tas.; also in New Zealand. Map 225.

N.S.W.: Nellies Glen, Katoomba, *T.Whitlegge s.n.* (NSW). Tas.: Mt Anne, *J.R.Croft 10198* (CANB); Adamsons Peak, *D.H.Norris 27049* (CANB).

Sporophytes are uncommon, and the relevant characters in the foregoing description are based on a single specimen. Many authors have suggested that var. *aristatum* is the only variety occurring in Australia, and that var. *pennatum* is absent. I agree with this view.

Doubtful Species

Rhizogonium alpestre Müll.Hal., *Hedwigia* 36: 333 (1897)

The original and rather vague description by Müller is the only known report of this species. Watts & Whitelegge (*J. Linn. Soc. New South Wales* 30 (Suppl.): 146, 1906) suggested that it might belong in *Porotrichum*. The type specimen (formerly in B, and probably destroyed during the Second World War) was collected from Mt Wellington, Tas., but this moss has not been found since.

CALOMNIACEAE

David G. Catcheside† & *Graham H. Bell*[1]

Calomniaceae Kindb., *Bot. Centralbl.* 77: 394 (1899).

Type: *Calomnion* Hook.f. & Wilson

Dioicous. Very slender mosses forming mats on trunks of tree ferns, yellowish green to orange-green. Stems short, erect, filiform, usually less than 10 mm tall, simple, arising from a persistent creeping protonema. Protonema a robust caulonema with pinnate to bipinnate filamentous yellowish green prostrate branches; cells verrucose. Leaves rudimentary, distant, fragile and caducous below, larger and more crowded above, in 3 rows (2 lateral and 1 dorsal), dimorphic; lateral leaves inserted transversely, patent, little-altered when dry, oblong to oblong-lanceolate, acute; dorsal leaves smaller, appressed, apiculate; laminal cells small, isodiametric, 4–6-sided, pellucid, smooth. Perichaetia and perigonia terminal. Perigonia gemmiform. Perichaetial leaves longer, erect, narrowly oblong or linear-spathulate. Calyptra narrow, cucullate, papillose apically. Setae short, slender. Capsules ovate-cylindrical, erect, symmetrical, brown; mouth reddish; operculum with a long beak, inclined, more than half the length of the theca. Peristome absent.

This family contains a single genus and nine species: one in New Zealand and south-eastern Australia; one endemic to the southern South Island of New Zealand; and one each in Lord Howe Is., Samoa, French Polynesia, Vanuatu, New Caledonia, Ceram (Indonesia) and Norfolk Is., all closely similar, and almost always growing on the trunks of tree ferns. The family is probably most closely related to the Mitteniaceae and Rhizogoniaceae.

V.F.Brotherus, Calomniaceae, *Nat. Pflanzenfam.*, 2nd edn, 10: 422–424 (1924); G.O.K.Sainsbury, A handbook of New Zealand mosses, *Bull. Roy. Soc. New Zealand* 5: 292–293 (1955); J.D.Hooker & W.Wilson, *Calomnion*, *in* J.D.Hooker, *Fl. Nov.-Zel.* 2: 97 (‘1855’) [1854]; I.G.Stone, Nomenclatural changes and new moss species in Australia; including a description of the protonema of *Calomnion*, *J. Bryol.* 16: 261–273 (1990); D.H.Vitt, The genus *Calomnion* (Bryopsida): taxonomy, phylogeny, and biogeography, *Bryologist* 98: 338–358 (1995).

CALOMNION

Calomnion Hook.f. & Wilson, *in* J.D.Hooker, *Fl. Nov.-Zel.* 2: 97 (‘1855’) [1854]; from the Greek *kalos* (beautiful) and *mnion* (a moss).

Type: *C. laetum* Hook.f. & Wilson [= *C. complanatum* (Hook.f. & Wilson) Lindb.]

Gymnostomum sect. *Eucladon* Hook.f. & Wilson, *London J. Bot.* 3: 538 (1844). T: *G. complanatum* Hook.f. & Wilson [= *C. complanatum* (Hook.f. & Wilson) Lindb.]

Description as for the family.

Calomnion complanatum (Hook.f. & Wilson) Lindb., *Acta Soc. Sci. Fenn.* 10: 240 (1872)

Gymnostomum complanatum Hook.f. & Wilson, *London J. Bot.* 3: 538 (1844). T: Bay of Islands, North Island, New Zealand, [1841], *J.D.Hooker*; lecto: BM, *fide* D.H.Vitt, *Bryologist* 98: 340 (1995); isolecto: BM, FH.

Calomnion laetum Hook.f. & Wilson, *in* J.D.Hooker, *Fl. Nov.-Zel.* 2: 97 (‘1855’) [1854], *nom. illeg.*, *incl. spec. prior*. T: “Northern Island”, Bay of Islands, New Zealand, [1841], *J.D.Hooker*; syn: BM-Wilson *n.v.*; Waikehi, *Sinclair*; syn: BM-Wilson *n.v.*

[1] State Herbarium of South Australia, Plant Biodiversity Centre, Hackney Road, Hackney, South Australia 5069.

Illustrations: G.O.K.Sainsbury, *Bull. Roy. Soc. New Zealand* 5: 291, fig. 3 (1955), as *C. laetum*; I.G.Stone, *J. Bryol.* 16: 271, fig. 1 (1990); D.H.Vitt, *Bryologist* 98: 341, figs 8–14 (1995).

Plants to 10 mm long. Leaves often caducous; lateral leaves elliptic to oblanceolate, often curling inwards dorsally when dry, 0.75–1.25 mm long; dorsal leaves broadly ovate to orbicular, c. half the length of the lateral leaves; in both types margin unistratose, plane, minutely and regularly crenulate; costa ending a little below the apex; laminal cells 7–10 µm diam. Perichaetial leaves crowded and overlapping, linear-spathulate, 2.5–3.0 mm long. Setae 2–3 mm long. Capsules ovate-cylindrical, exserted, c. 1 mm long. Spores c. 14 µm diam., brown. Plates 54, 55.

Very rare on the trunks of trees ferns in humid gullies in N.S.W., Vic and Tas. Also in New Zealand. Map 226.

N.S.W.: Cambewarra Mtn, *W.W.Watts 6568* (NSW); Waterfall Track, Mt Wilson, 25 Sept. 2001, *E.A.Brown* (AD, NSW). Vic.: Ferny Glade, on track to Sealers Cove, 6 Apr. 1994, *D.A.Meagher* (MEL). Tas.: Dip Falls, S of Stanley, *I.G.Stone 25273* (HO, MEL).

Sporophytes are apparently rare in Australian material, only one fertile specimen having being observed. This species is readily confused with other small mosses (e.g. *Rhizogonium* spp. and *Hymenodon pilifer*) that project horizontally from tree fern trunks, so it has possibly been overlooked. Listed as endangered in Australia (G.A.M.Scott *et al.*, *A Conservation Overview of Australian Non-marine Lichens, Bryophytes, Algae and Fungi* 100, 1997) and, in Victoria, as a Threatened taxon under the Flora and Fauna Guarantee Act 1988 (Vic.).

MITTENIACEAE

Ilma G. Stone†

Mitteniaceae Broth., *Nat. Pflanzenfam.* I, 3: 532 (1903).

Type: *Mittenia* Lindb.

Dioicous. Plants gregarious or scattered on soil, slender, complanate, the leaves distichous or with an intermittent third row. Stems with a central strand, simple or branching from basal buds, brownish, bare below. Protonema with two phases, either transitory with normal cylindrical cells or, in very shaded habitats, persistent with highly refractive lenticular cells, reproducing by gemmae. Rhizoidal gemmae occasionally present. Leaves blue-green, distant, bract-like in lower part of stem, often overlapping above, oval to oblong, vertically to obliquely inserted, asymmetrical with the basiscopic lamina long-decurrent; apex short-apiculate to rounded; margin usually entire, occasionally crenulate; costa failing above mid-leaf; laminal cells subquadrate to rounded-hexagonal. Fertile shoots usually with at least perichaetial leaves radially arranged and with transverse insertions. Perichaetia terminal. Calyptra short-conical, persistent on tip of operculum. Capsules exserted, cylindrical; operculum finely tapered. Peristome double, red-brown, with 16 long slender tapered exostome teeth and c. 32 nodulose endostome processes forming a dome over the capsule mouth.

A monotypic family with a single species; native to New Guinea, Australia and New Zealand.

Opinions vary concerning the order to which Mitteniaceae belongs. *Mittenia* was originally placed in the Mniaceae (Bryales) by W.Mitten (1860), but Brotherus (1903) introduced Mitteniaceae, still in the Bryales, and this has been accepted by most modern authors. Shaw (1985) argued that the unique peristome structure warrants a new order Mitteniales, whereas Stone (1986) suggested that placement in Schistostegales would be more appropriate considering that *Schistostega* D.Mohr and *Mittenia* have the same distinctive protonema, some vegetative similarities and, although the former lacks a peristome, the internal structure of the capsule does not preclude a relationship with *Mittenia*. The family was placed in the Rhizogoniales in Buck & Goffinet's (2000) classification.

W.Mitten, Description of some new species of Musci from New Zealand…, *J. Proc. Linn. Soc.*, *Bot.* 4: 64–100 (1860); V.F.Brotherus, Mitteniaceae, *Nat. Pflanzenfam.* I, 3: 532 (1903); V.F.Brotherus, Mitteniaceae, *Nat. Pflanzenfam.*, 2nd edn, 10: 422–423 (1924); G.O.K.Sainsbury, A handbook of New Zealand mosses, *Bull. Roy. Soc. New Zealand* 5: 1–490 (1955); I.G.Stone, The highly refractive protonema of *Mittenia plumula* (Mitt.) Lindb. (Mitteniaceae), *Proc. Roy. Soc. Victoria* 74: 119–124 (1961); I.G.Stone, The gametophore and sporophyte of *Mittenia plumula* (Mitt.) Lindb., *Austral. J. Bot.* 9: 124–150 (1961); A.J.Shaw, Peristome structure in the Mitteniales (ord. nov.: Musci), a neglected novelty, *Syst. Bot.* 10: 224–233 (1985); I.G.Stone, The relationship between *Mittenia plumula* (Mitt.) Lindb. and *Schistostega pennata* (Hedw.) Web. & Mohr, *J. Bryol.* 14: 301–314 (1986); W.R.Buck & B.Goffinet, Morphology and classification of mosses, *in* A.J.Shaw & B.Goffinet (eds), *Bryophyte Biology*: 71–123 (2000).

MITTENIA

Mittenia Lindb., *Öfvers. Förh. Kongl. Svenska Vetensk.-Akad.* 19: 606 (1863); named in honour of the British bryologist William Mitten (1819–1906).

Type: *M. plumula* (Mitt.) Lindb.

Mniopsis Mitt., *in* J.D.Hooker, *Fl. Tasman.* 2: 187 (1859); *nom. illeg. non Mniopsis* Mart., *Nov. Gen. Sp. Pl.* 1(1): 3 (1823). T: *Mniopsis plumula* Mitt. [= *Mittenia plumula* (Mitt.) Lindb.]

Description as for the family.

Mittenia plumula (Mitt.) Lindb., *Öfvers. Förh. Kongl. Svenska Vetensk.-Akad.* 19: 606 (1863)

Mniopsis plumula Mitt., *in* J.D.Hooker, *Fl. Tasman*. 2: 187 (1859). T: Ovens Ck, Tas., *W.Archer*; syn: NY; isosyn: NY.

Mniopsis rotundifolia Müll.Hal., *Hedwigia* 36: 332 (1897); *Mittenia rotundifolia* (Müll.Hal.) Paris, *Index Bryol.*, Suppl. 1: 248 (1900). T: Lilyvale, N.S.W., Sept. 1891, *T.Whitelegge*; iso: H-BR *n.v.*, *fide* H.N.Dixon & E.B.Bartram, *Bot. Not.* 1937: 77 (1937).

Illustrations: G.O.K.Sainsbury, *Bull. Roy. Soc. New Zealand* 5: 291, fig. 2 (1955); I.G.Stone, *Proc. Roy. Soc. Victoria* 74: 119–124, figs 1–20, pl. XX–XXII (1961); I.G.Stone, *Austral. J. Bot.* 9: 124–151, figs 1–81, pl. 1–4 (1961).

Stems 5–20 mm tall, solitary or clustered. Leaves mostly less than 1 mm long; costa in T.S. composed of a central group of 2–8 stereids surrounded by large chlorophyllose cells; laminal cells firm-walled, isodiametric, c. 18–29 µm wide. Perigonial and perichaetial leaves, ligulate to oblanceolate, c. 1.5–2.0 mm long, 0.30–0.45 mm wide; costa reaching to c. three-quarters of leaf length; laminal cells short-oblong. Setae 1 or more per perichaetium, 2–3 mm long, geniculate, pale greenish yellow. Theca and operculum each c. 1.00–1.25 mm long. Spores globose, 8–12 µm diam., green, slightly spiculose. n = 10, *fide* H.P.Ramsay (pers. comm.). Plates 56, 57.

Not uncommon in eastern Australia where it occurs from south-eastern Qld through N.S.W, A.C.T., Vic. and Tas.; also known from an isolated locality in south-western W.A. Usually found in higher rainfall areas, from sea level to alpine regions, colonising steeply inclined earth banks, earth on the bases of uprooted trees, under rock overhangs and in wombat holes, also the decomposing walls of caves; usually on soils derived from granite, basalt or sandstone. Also in New Guinea and New Zealand. Map 227.

W.A.: Mt Chudalup, *I.G.Stone 6530* (MEL). Qld: Blackdown Tableland, *I.G.Stone 20150* (MEL). N.S.W.: Dorrigo, *I.G.Stone 17811* (MEL). Vic.: Byaduk Caves, *I.G.Stone 9499* (MEL). Tas.: Russell Falls, *I.G.Stone 3246* (MEL).

In deep shade the specialised, luminous green protonema, indistinguishable from that of the Northern Hemisphere species *Schistostega pennata* (Hedw.) F.Weber & D.Mohr, sometimes covers very large areas and can persist for many years, reproducing asexually and forming few or no sterile gametophores. On more exposed earth banks, fertile gametophores can form a dense turf with little or no evidence of a persistent protonema; these reproduce by spores and regrowth from old fragments of stem.

RACOPILACEAE

Bernard O. van Zanten[1]

Racopilaceae Kindb., *Bot. Centralbl.* 76: 85 (1898).

Type: *Racopilum* P.Beauv.

Dioicous (in Australia). Rather slender to medium-sized mosses in green or yellowish green mats. Stems to c. 10 cm long, creeping, subpinnately branched, ventrally densely tomentose with tufts of smooth dark brown branched rhizoids arising near base of lateral leaves; central strand narrow. Stem and branch leaves similar, dorsiventrally flattened, inserted in 6 (seemingly 2) lateral and 2 dorsal rows, dimorphic; lateral leaves decurrent by 1 or 2 cells, oblong-ovate, slightly asymmetrical; dorsal leaves smaller, triangular-ovate; costa single, excurrent as a smooth arista (except *Powellia involutifolia*); leaf border absent (except *P. involutifolia*); laminal cells (sub)isodiametric, rhomboidal-hexagonal, smooth or mammillose, 8–30 µm long. Calyptra cucullate, rarely mitrate. Sporophyte lateral. Setae elongate, smooth (in Australia). Capsules cylindrical, usually curved, deeply grooved (erect, not curved and ±smooth in *Powellia*), annulate; operculum conical-rostrate. Peristome double, hypnoid in *Racopilum*, reduced in *Powellia*. Spores isomorphic, smooth, 10–20 µm diam., green.

This family of two genera (*Racopilum* and *Powellia*) and c. 20 species is widely distributed in the tropics, subtropics and temperate regions of the Southern Hemisphere. Most species are restricted to rainforest, but Australian representatives also tolerate drier and more exposed sites. These mosses forms mats on bark, rotting wood, rock or earth. Both genera are represented in Australia by two species. New Zealand has an endemic species (*R. robustum* Hook.f. & Wilson) which may yet be found in Australia. It is characterised by a more robust habit and almost isomorphic leaves.

B.O. van Zanten, De afgrenzing van het geslacht *Powellia* tegen *Racopilum* (Musci), *Jaarb. Kon. Ned. Bot. Ver*. 1969: 54–57 (1970); T.Koponen & D.H.Norris, Bryophyte flora of the Huon Peninsula, Papua New Guinea. XVII. Grimmiaceae, Racopilaceae and Hedwigiaceae (Musci), *Acta Bot. Fenn.* 133: 81–106 (1986).

KEY TO GENERA

Leaves bordered by narrow elongate cells and the costa percurrent, or leaves without a border and the costa excurrent in a long arista; laminal cells bulging; capsules erect, cylindrical, straight, smooth or nearly so; exostome teeth papillose, not or only striate at base; endostome basal membrane very low; processes fugacious; cilia absent; setae twisted to the left ....**1. POWELLIA**

Leaves without a border; costa excurrent; laminal cells smooth or with a central mammilla; capsules erect to horizontal, cylindrical, curved or ±straight, deeply grooved; exostome teeth striate, papillose at tips; endostome basal membrane c. half the height of the exostome; processes and cilia well developed; setae twisted to the right in upper half and to the left in lower half ....**2. RACOPILUM**

1. POWELLIA

Powellia Mitt., *London J. Bot*. 10: 187 (1868); named after the Rev. T.Powell, collector of the genus.

Type: *P. involutifolia* Mitt.

Lateral leaves ovate to narrowly ovate-elliptic, obtuse to acute, 1.4–2.0 mm long, 0.3–0.9 mm wide, spreading sideways or obliquely forwards when moist, curved upwards when dry;

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margin undulate, either bordered by elongate cells or unbordered, ±entire to serrulate near the apex; costa percurrent or excurrent in a long arista; laminal cells quadrate to rhomboidal-hexagonal, 10–20 µm, firm-walled, bulging. Dorsal leaves smaller, triangular-ovate. Perichaetial leaves ovate, blunt, acute or acuminate; cells thin-walled, 60–80 × 12–20 µm; paraphyses usually projecting beyond bracts. Calyptra cucullate. Setae 5–10 mm long, yellowish brown, twisted to the left. Capsules erect, cylindrical, straight, smooth or nearly so. Exostome teeth narrow, papillose, yellowish; endostome rudimentary, with a low basal membrane; processes fugacious; cilia absent.

A genus of five tropical species with scattered distributions in Malesia, tropical Australia (two non-endemic species) and the Pacific Islands.

Costa excurrent in a long arista; leaves not bordered .... **1. P. integra**

Costa percurrent; leaves bordered by a band of linear cells .... **2. P. involutifolia**

1. Powellia integra (Dixon) Zanten, *Bryobrothera* 5: 21 (1999)

Racopilum integrum Dixon, *J. Bot.* 79: 61 (1941). T: Sarawak, Borneo, [Malaysia], 1888, *Everett 503*; holo: BM.

Racopilum brevisetum E.B.Bartram, *Occas. Pap. Bernice P. Bishop Mus.* 19: 226 (1948); *Powellia breviseta* (E.B.Bartram) Zanten, *Jaarb. Kon. Ned. Bot. Ver.* 1969: 56 (1970), *nom. inval.*; *Proc. Sixth Meeting Central & East European Bryol. Working Group* 3 (1989). T: Mt Victoria, Viti Levu, Fiji, *A.C.Smith 1151*; holo: FH.

Illustration: T.Koponen & D.H.Norris, *Acta Bot. Fenn.* 133: 88, fig. 3b, c, f, j–l (1986), as *Racopilum cuspidigerum*.

Phyllodioicous. Lateral leaves ovate or narrowly ovate, 1.4–1.8 mm long, 0.6–0.8 mm wide; apex obtuse or acute, strongly incurved when dry (arista usually pointing downwards); margin undulate, serrulate due to projecting cell tips; costa ending in a smooth arista 0.2–0.3 mm long, protruding at the back of leaf when dry; laminal cells rhomboidal-hexagonal, strongly bulging, 15–20 µm long, progressively smaller towards the margin, 12–15 µm long, not forming a border; juxtacostal cells rectangular, parenchymatous, 30–50 × 10–14 µm. Dorsal leaves 0.8–1.4 mm long, 0.3–0.6 mm wide, acute. Perichaetial leaves ovate, gradually long-acuminate to a smooth arista c. 2 mm long. Calyptra with numerous erect hairs. Setae 5–7 mm long, yellowish brown, left-turned (1–2 turns). Capsules erect, cylindrical, smooth; operculum not seen. Exostome teeth papillose, striate near base; basal membrane of endostome very low; processes fragile; cilia absent. Spores 11–12 µm diam.

Two collections are known from the Cairns area, north-eastern Qld; also in Fiji, Papua New Guinea, Indonesia (Borneo, Ceram), Malaysia and the Philippines (Luzon). Reported here for the first time from Australia, it was collected on branches in rather exposed forest sites at altitudes of 1000–1200 m. Map 228.

Qld: State Forest 194, 15 km SW of Atherton, *B.O. van Zanten 68.1238A* (CANB, GRO); summit of Black Mtn, 25 km NW of Kuranda, *B.O. van Zanten 68.1341* (CANB, GRO).

All Australian specimens are female, and sporophytes are unknown here. The description of the sporophyte is based on the Fijian type. Dwarf male plants were observed only in one specimen from Fiji (*A.C.Smith 5300*).

The gametophyte closely resembles that of *Racopilum cuspidigerum*, but it can be distinguished by the bulging laminal cells. The easiest way to establish the presence of these bulges is to examine a folded leaf. Other vegetative differences between this species and *R. cuspidigerum* are the more strongly undulate leaf margin (hence *Powellia* has a less distinctly complanate appearance than *Racopilum*), dorsally stronger protruding costa, stronger incurved, not longitudinally convolute and more constantly laterally-spreading leaves, and the more yellowish colour. Koponen & Norris (1986), synonymised this species with *R. cuspidigerum*; however, this view is not accepted due to significant differences in the sporophyte and gametophyte.

2. Powellia involutifolia Mitt., *J. Linn. Soc., Bot.* 10: 187 (1868)

T: Fangasa Bay, Tutuila, [Western] Samoa, *T.Powell 43*; holo: NY; iso: BM, MO.

Helicophyllum australe Hampe, *Linnaea* 36: 524 (1870); *Powellia australis* (Hampe) Broth., *Nat. Pflanzenfam.* I, 3: 975 (1907). T: Rockingham Bay, Qld, *J.Dallachy s.n.*; holo: BM; iso: MEL, MO.

Illustrations: V.F.Brotherus, *Nat. Pflanzenfam.*, 2nd edn, 11: 51 (1925); T.Koponen & D.H.Norris, *Acta Bot. Fenn.* 133: 97, fig. 9a–g (1986).

Male plants similar in size to female. Lateral leaves narrowly ovate-elliptic, strongly incurved and ±spirally twisted when dry, 1.5–2.0 mm long, 0.7–0.9 mm wide; apex obtuse; margin entire or with a few small blunt teeth; costa percurrent, ending 1–3 cells below apex, strongly protruding at back of leaf when dry; laminal cells (sub)isodiametric, quadrate-hexagonal, 10–15 × 8–10 µm, strongly bulging; basal cells scarcely differentiated, but a few cells to 20 µm long; marginal cells smooth, in 1–3 rows, thick-walled, linear, to 80 µm long, forming a distinct yellowish border, failing below apex. Dorsal leaves obtuse, smaller. Perigonial leaves broadly ovate, acute, c. 0.4 mm long. Perichaetial leaves ovate, acute to blunt or acuminate, sometimes irregularly toothed toward apex, 1.1–1.2 mm long, with or without a costa. Calyptra with some erect or hanging hairs near the base. Setae 6–7 mm long, yellowish to reddish brown, twisted to the left, sometimes to the right (at most a half turn) just below capsule. Capsules erect, cylindrical or narrowly elliptic, narrowed at mouth, 2.0–2.5 mm long, smooth or faintly irregularly ribbed when dry; operculum 0.6–0.8 mm long, obliquely rostrate; rostrum straight. Exostome yellowish, papillose, not perforated, or with narrow perforations along the ±straight median line; endostome a low basal membrane; processes rudimentary or absent(?); cilia absent. Spores 14–15 µm diam.

Occurs in Qld, from Cairns south to Mackay; also in New Guinea, New Caledonia, Fiji, Samoa and the Cook Islands. Primarily an epiphyte, it has also been recorded from rock and soil, from sea level to 800 m. It is found mainly in rainforest, but also in wet-sclerophyll forest. Map 229.

Qld: Pat Daley Park, S of Millaa-Millaa on Ravenshoe road, *D.H.Norris* (CANB, GRO); road towards Conway State Forest, Whitsunday Coast, *B.O. van Zanten & P.Sollman 93.10.2749* (CANB, GRO).

This moss is readily recognised by the peculiar, spirally twisted leaves together with the complanate leaf insertion and strongly tomentose stems. Only two of the known collections bear sporophytes.

The type of *P. australis* is identical to that of *P. involutifolia* in terms of vegetative morphology and anatomy. However, the sporophytes could not be compared as the holotype of *P. australis* (BM) lacks capsules (the MO isotype, however, has one seta twisted to the left, which is usual for this species), Nevertheless, the sporophytic characteristics of Australian and extra-Australian specimens of both taxa are very similar. Synonymy of *P. australis* with *P. involutifolia* was suggested by Koponen & Norris (1986).

2. RACOPILUM

Racopilum P.Beauv., *Prodr. Aethéogam.* 36 (1805); from the Greek *rhaco* (lacerate) and *pilos* (hair), in reference to the lacerate, pilose calyptra.

Orthographic variant: *Rhacopilum*.

Lecto: *R. mnioides* P.Beauv. [= *R. tomentosum* (Hedw.) Brid.]

Dwarf male plants on female plant leaves (phyllodioicous); normal-sized male plants rare. Lateral leaves oblong-ovate, obtuse to acute, spreading laterally when moist, curved upwards and longitudinally convolute when dry, 1–2 mm long (excluding arista), 0.3–0.9 mm wide; margin plane or slightly undulate near leaf base, unbordered, serrulate to serrate towards the apex, rarely almost entire; costa excurrent as a smooth arista of variable length; laminal cells irregular, (sub)isodiametric, short-rhomboidal to hexagonal, often in oblique rows (then shape more regular), (8–) 10–22 (–30) µm long, thin- to firm-walled, both sides smooth or unimammillose; cells at basal margins and towards base short-rectangular; dorsal leaf shape

and size very variable, symmetrical, obliquely forward-pointing, narrowly triangular to ovate. Perichaetial leaves sheathing, broadly ovate, c. 1.5–1.8 mm long; costa long-excurrent; laminal cells rectangular, 60–80 µm long; paraphyses hair-like, often projecting beyond bracts. Setae 7–30 mm long, yellowish or reddish, twisted to the right in upper part and to the left in lower part. Capsules inclined or horizontal, rarely ±erect, (2.0–) 2.5–3.5 (–4.5) mm long (excluding lid), curved or nearly straight, a small bend just below the oblique orifice; neck short, strumose or not, deeply grooved, with stomata; operculum 0.7–1.8 mm long, rostrate from a convex-conical base; rostrum erect or oblique, (0.5–) 0.7–0.9 (–1.0) mm long, straight or hooked. Exostome brownish; teeth narrowly lanceolate, transversely striate, with a zig-zag median line on outer face, barred on inner face, papillose above; endostome segments well developed; basal membrane c. half the exostome height, smooth; segments broad, keeled, broadly perforated, as long as exostome or slightly shorter; cilia 2 or 3, well developed, nodose or appendiculate.

This predominantly tropical and subtropical genus of about 15 species occurs in both hemispheres and in temperate regions of the Southern Hemisphere; species diversity is greatest in the Malesian region. Two non-endemic species and an additional variety are known from Australia.

The genus is often spelled as "*Rhacopilum*", which is linguistically correct, but the original spelling by Palisot de Beauvois is followed here.

B.O. van Zanten & A.Hofman, On the origin and taxonomic status of *Racopilum chilense* (Musci, Racopilaceae) by using electrophoretic analysis, *Fragm. Florist. Geobot.* 40: 405–416 (1995).

Capsules not strumose; setae 0.15–0.20 mm thick; calyptra cucullate; hairs few to numerous; laminal cells smooth or mammillose .... **1. R. cuspidigerum**

Capsules strumose; setae 0.2–0.4 mm thick; calyptra mitrate; hairs numerous; laminal cells mammillose........ **2. R. strumiferum**

1. Racopilum cuspidigerum (Schwägr.) Ångstr., *Öfvers. Förh. Kongl. Svenska Vetensk.-Akad.* 29(4): 10 (1872)

Hypnum cuspidigerum Schwägr., *in* Gaudichaud, *in* Freycinet, *Voy. Uranie, Bot.* 229 (1828). T: Hawaiian Is., *Gaudichaud*; syn: BM.

Laminal cells (10–) 12–18 (–30) µm long, smooth to strongly mammillose. Calyptra cucullate; hairs erect, few to numerous. Setae (10–) 12–25 (–30) mm long, 0.15–0.20 mm thick. Capsule neck rather short, not strumose; rostrum erect or oblique, straight or hooked, 0.5–0.8 mm long. $n = 10$, *fide* H.P.Ramsay, *in* A.Löve, *Taxon* 16: 557 (1957); *Austral. J. Bot.* 22: 321 (1974).

Two varieties are recognised.

Laminal cells smooth or only weakly mammillose; paraphyses not or only slightly projecting beyond perichaetial bracts .... **1a.** var. **cuspidigerum**

Laminal cells distinctly mammillose; paraphyses usually projecting beyond perichaetial bracts .... **1b.** var. **convolutaceum**

1a. Racopilum cuspidigerum (Schwägr.) Ångstr. var. cuspidigerum

Racopilum amboinense Broth., *Phillip. J. Sci.*, Sect. C, 12: 79 (1917). T: Ambon, [Indonesia], *Robinson 2286*, *2299*; syn: H.

Racopilum purpurascens Hampe, *Linnaea* 40: 326 (1876). T: Mt Elephant, Vic., *F.Mueller*; holo: BM; iso: MEL.

[*Racopilum tomentosum auct. non* (Hedw.) Brid.: F.M.Bailey, *Compr. Cat. Queensland Pl.* 663 (1913)]

Illustrations: M.Fleischer, *Musci Buitenzorg* 4: 1623 (1923); T.Koponen & D.H.Norris, *Acta Bot. Fenn.* 133: 88, fig. 3a–l (1986).

Laminal cells smooth or only weakly mammillose. Leaf margin not or faintly undulate near the base when moist. Perichaetial paraphyses hair-like, not or slightly projecting beyond the

bracts. Calyptra usually with few hairs, but sometimes distinctly hairy. Rostrum usually oblique, hooked or straight.

Common in eastern Qld, N.S.W. and A.C.T.; also (sub)tropical SE Asia, Oceania and Costa Rica. Grows on a broad range of substrata (rocks, boulders, tree bases, rotting wood and soil) in wet- and dry-sclerophyll forest and rainforest from sea level to c. 1250 m; it also tolerates rather dry, ±exposed sites. Map 230.

Qld: Mt Bartle Frere, 29 Nov. 1936, *H.Flecker* (BM). N.S.W.: Cox Rd, Toonumbar State Forest, 29 km NW of Kyogle, *H.Streimann 6988* (CANB, GRO). A.C.T.: Molonglo Gorge, *N.T.Burbidge 7125* (CANB).

This dioicous taxon is sometimes misidentified as *R. tomentosum* (Hedw.) Brid., a similar but monoicous, tropical American species which does not occur in Australia.

Transitional forms with var. *convolutaceum* are common in N.S.W. and southern Qld and rare elsewhere in Australia. They are also rare in Malesia, Sri Lanka, southern India, the Ryu-Kyu Is. and several Pacific islands.

An aberrant specimen was misidentified as *R. robustum* Hook.f. & Wilson by Catcheside (S.A.: Bagot's Gymnosperm Garden, Aldgate, southern Lofty, *D.G.Catcheside 31176*, AD) probably because of its subisophyllous leaves. This New Zealand species, however, is less branched, and its larger lateral leaves are 2–3 mm long.

Vegetative reproduction by means of caducous leaves, which readily produce new plants from the base of the costa, is frequently observed in var. *cuspidigerum* from the Malesian region. This phenomenon was not observed in Australian plants.

Rare specimens from north-eastern Qld (mainly in the Cairns area) have a very short-excurrent costa and a rounded leaf apex. In some cases, these branches are connected to stems with more acute leaf apices and longer-excurrent costae. Moreover, all such specimens were collected in river beds indicating that these characteristics may have been induced by moist conditions. These specimens cannot be distinguished from *R. amboinense* Broth., a species synonymised with *R. cuspidigerum* by Koponen & Norris (1986).

The type of *R. purpurascens* is characterised by smooth, thin-walled laminal cells that are very variable in size (to 30 µm long). The basal juxtacostal cells are rectangular, very lax, up to 40 µm long and shrivelled when dry. These characteristics are probably induced by the moist habitat of the type, i.e. irrigated basaltic rock. Scott & Stone (1976) suggested that *R. purpurascens* was conspecific with *R. convolutaceum*. However, I feel that its smooth laminal cells indicate conspecificity with *R. cuspidigerum* var. *cuspidigerum*.

1b. **Racopilum cuspidigerum** var. **convolutaceum** (Müll.Hal.) Zanten & Dijkstra, *Fragm. Florist. Geobot.* 40: 411 (1995)

Hypopterygium convolutaceum Müll.Hal., *Syn. Musc. Frond.* 2: 13 (1850); *Racopilum convolutaceum* (Müll.Hal.) Reichardt, *Reise Novara, Pilze, Leber-Laubm.* 1(3): 194 (1870). T: "Nova Hollandia, Isle de King", [W.A.], *L.Preiss*; holo: B *n.v.* (probably destroyed); neo: BM, East Gippsland, Vic., *F.Mueller*, Herb. Hampe 1881, *fide* B.O. van Zanten, *op. cit*. 411 (1995).

Racopilum cristatum Hook.f. & Wilson, *in* J.D.Hooker, *Fl. Nov.-Zel.* 2: 121 ('1855') [1854]. T: Tehawera forest, North Is., New Zealand, *W.Colenso 2540*; holo: BM.

Racopilum crinitum Hampe, *Linnaea* 36: 525 (1870). T: Porongorups, W.A., Oct. 1867, *F.Mueller*; holo: BM; iso: MEL, NY.

Illustrations: D.G.Catcheside, *Mosses of South Australia* 292, fig. 175 (1980); H.Streimann, *The Mosses of Norfolk Island* 136, fig. 61 (2002), as *R. cuspidigerum.*

Laminal cells distinctly mammillose; cells of leaf base and margin smooth. Leaf margin often somewhat undulate near base. Perichaetial paraphyses hair-like, usually projecting beyond bracts. Calyptra with few or numerous hairs. Rostrum erect or oblique, straight, rarely hooked. Plate 58.

A common variety in southern W.A., eastern S.A., Qld (rare and usually at higher elevations in tropical Qld), N.S.W., A.C.T., Vic. and Tas.; also in New Zealand (rather rare), some Pacific islands (Lord Howe, Norfolk, Kermadec, Cook and Austral Is.) and central Chile

(probably introduced on timber imported from Australia). The ecology is very similar to that of var. *cuspidigerum*. Map 231.

W.A.: Pemberton, *G.G.Smith 82* (FH, MEL). S.A.: Aldgate, *L.D.Williams 649* (MEL). Qld: Murphies Ck, 16 km NE Toowoomba, *H.Streimann 369* (CANB). N.S.W.: Larrys Mtn, 10 km NW of Moruya, *H.Streimann 3666* (CANB, GRO). A.C.T.: Tidbinbilla Nature Reserve, *H.Streimann 1415* (CANB). Vic.: Tarwin R., *F.Mueller 16* (MEL). Tas.: Mt Dromedary, *R.A.Bastow 640* (MEL).

There is a clear correlation between the mammillosity of the laminal cells and geographical location. Thus, cells are smooth in tropical Qld, distinctly mammillose in southern Australia, with intermediate forms (along with smooth and mammillose-celled plants) occurring in N.S.W. and southern Qld. These intermediates often have smooth and mammillose-celled leaves on the same plant, and they also occur rarely in Vic. and Tas. and in northern Qld where they are restricted to higher altitudes. Because of these intermediates, *R. convolutaceum* is considered to be only a variety of *R. cuspidigerum*.

There is a tendency for the curvature of the capsules to be somewhat more pronounced in var. *convolutaceum* than in var. *cuspidigerum*, and a hooked rostrum is more often present in the latter. Specimens from W.A. are characterised by a narrower leaf apex combined with very strongly mammillose laminal cells.

2. **Racopilum strumiferum** (Müll.Hal.) Mitt., *J. Proc. Linn. Soc., Bot.* 4: 93 (1860)

Hypopterygium strumiferum Müll.Hal., *Bot. Zeitung (Berlin)* 9: 563 (1851). T: prope Kaipara, New Zealand, *S.Mossman 732*; holo: B *n.v.* (probably destroyed); iso: BM, NY.

Racopilum australe Hook.f. & Wilson, *in* J.D.Hooker, *Fl. Nov.-Zel.* 2: 121 (‘1855’) [1854]. T: South Is., New Zealand, *W.Colenso 105*; holo: BM.

Illustrations: G.O.K.Sainsbury, *Bull. Roy. Soc. New Zealand* 5: 325, pl. 49, fig. 3 (1955); J.Beever, K.W.Allison & J.Child, *Mosses of New Zealand*, 2nd edn 111, fig. 51 (1992), as *R. convolutaceum*.

Laminal cells (8–) 10–14 (–16) µm long, strongly mammillose. Lower leaf margin usually ±undulate. Perichaetial paraphyses hair-like, projecting beyond bracts. Calyptra mitrate; hairs numerous, erect. Setae 7–18 (–20) mm long, 0.2–0.4 mm thick. Capsules slightly to strongly curved, distinctly strumose; rostrum erect, straight, (0.5–) 0.7–1.0 (–1.1) mm long. $n = 10$, *fide* H.P.Ramsay, *in* A.Löve, *Taxon* 16: 557 (1957); *Austral. J. Bot.* 22: 321 (1974).

Known from S.A. and Tas.; also very common in New Zealand. Ecological data are not available for Australian specimens. However, in New Zealand it grows in rainforest on various substrata (soil, rock, bark, rotting wood, rarely epiphyllous) from sea level to c. 1000 m. Map 232.

S.A.: Waterfall Gully, Mt Lofty Ra., 10 km SE of Adelaide, *H.B.S.Womersley 12* (AD); Waterfall Gully, at the second waterfall, *D.E.Symon 51*, *52* (Herb. C.C.Townsend). Tas.: locality unknown, *W.Archer* (BM); locality unknown, *R.A.Bastow 68 p.p.* (S) [mixed with *R. cuspidigerum* var. *convolutaceum*, this specimen is labelled “Australia”, but probably comes from Tasmania as Bastow collected there (incl. Mt Dromedary) in 1886].

Specimens without sporophytes cannot be distinguished with certainty from *R. cuspidigerum* var. *convolutaceum*. The laminal cells of *R. strumiferum* are generally smaller, but there is such a degree of overlap that this character is of little use in separating the taxa. The rostrum is almost always erect in *R. strumiferum*, never hooked and often slightly longer than in *R. cuspidigerum*. To determine the presence of a struma it is necessary to examine mature, wet capsules because the plicae of dry capsules extent to the neck and can easily be mistaken for a struma. The presence of a struma is usually a reliable indicator of *R. strumiferum*.

Differences in the calyptra are even more reliable. In *R. cuspidigerum*, this has one fissure even when still cylindrical. When the calyptra widens the entire basal part is involved, leaving the mature calyptra conical and ultimately cucullate. By contrast, the calyptra of *R. strumiferum* lacks fissures in the cylindrical phase; when it widens only the section above the base is involved. This results in a ±narrowly pear-shaped calyptra. As the widening progresses the base ruptures in several fissures, and the calyptra becomes mitrate.

HYPOPTERYGIACEAE

Hans (J.D.) Kruijer[1]

Hypopterygiaceae Mitt., *J. Proc. Linn. Soc., Bot.,* Suppl. 1: 147 (1859).

Type: *Hypopterygium* Brid.

Dioicous or monoicous, unisexual or partly bisexual. Plants forming loose to dense groups of dendroids or fans, occasionally forming mats, pleurocarpous. Rhizome creeping, sympodially branched, tomentose. Stems horizontal (rarely creeping), ascending or erect, simple or branched and differentiated into stipe and rachis; branches usually lateral, rarely ventral, distant or closely set. Foliation complanate and anisophyllous or partly non-complanate and isophyllous. Leaves in 3, 8 or 11 (rarely more) ranks, but arranged in 2 lateral rows of asymmetrical leaves and a ventral row of smaller symmetrical leaves (amphigastria) in the distal part of the stem or frond, distant or closely set, symmetrical or asymmetrical; apex usually acuminate. Gemmae absent or filiform. Gametoecia usually lateral, occasionally dorsal or ventral. Calyptra cucullate or mitrate. Capsules subglobose to ovoid-oblong; operculum rostrate. Peristome diplolepideous; exostome teeth 16 (absent from *Catharomnion*); endostome with 16 processes, ciliate or not. Spores subglobose to broadly ellipsoidal, scabrous.

The family consists of seven genera and 21 species with a predominantly Gondwanan distribution. It occurs mainly in humid forests of warm-temperate to tropical areas of the world, and it is most diverse in Indo-Malaysia. Three genera and six species are known with certainty from Australia.

The Hypopterygiaceae have been regarded as comprising two subfamilies: Hypopterygioideae (*Canalohypopterygium*, *Catharomnion*, *Dendrocyathophorum*, *Dendrohypopterygium*, *Hypopterygium* and *Lopidium*) and Cyathophoroideae (Kindb.) Broth. (*Cyathophorum* and *Cyathophorella*). The former is characterised by gametophytes with branched stems differentiated into a stipe and rachis and by horizontal, ascending or vertical sporophytes. Cyathophoroideae have simple or weakly branched stems and horizontal to descending sporophytes. Some authors treated the Cyathophoroideae as a separate family; others proposed a different classification, and placed genera of the Hypopterygiaceae in the Daltoniaceae or Hookeriaceae. However, according to Kruijer (2002), the Hypopterygiaceae constitute a monophyletic group that is best retained as a separate family nested in the Hookeriales-Leucodontales-Hypnales clade. Thus, there is no need to distinguish subfamilies. In this treatment, the classification and circumscription of the family, its genera and species follow Kruijer (2002).

The name of the family Lophidiaceae Brid. ex Rodway (Rodway, 1914), based on *Lopidium*, is illegitimate because it includes *Hypopterygium*.

Species are very variable in size and habit, and distantly foliate plants often appear rather different to closely foliate individuals of the same species. Branched plants with a loose or distant ramification have a different appearance to those that are branched with numerous and closely set branches; both types of ramification often occur within the same species. Branches and leaves are oriented roughly at right angles to the direction of most intense incident light.

W.Mitten, Musci Indiae Orientalis, *J. Proc. Linn. Soc., Bot.*, Suppl. 1: 1–171 (1859); N.C.Kindberg, Studien über die Systematik der pleurokarpischen Laubmoose, *Bot. Centralbl.* 76: 84–87 (1898); N.C.Kindberg, Grundzüge einer Monographie über die Laubmoos-Familie Hypopterygiaceae, *Hedwigia* 40: 275–303 (1901); M.Fleischer, Hypopterygiaceae, in *Musc.*

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Buitenzorg 3: 1064–1097 (1908); L.Rodway, Lophidiaceae (sic), *Pap. & Proc. Roy. Soc. Tasmania* 1913: 234–239 (1914); V.F.Brotherus, Hypopterygiaceae, *Nat. Pflanzenfam.*, 2nd edn, 11: 270–278 (1925); H.N.Dixon, Hypopterygiaceae, *in* Studies in the bryology of New Zealand, *Bull. New Zealand Inst.* 3(5): 239–298 (1927); G.O.K.Sainsbury, A handbook of New Zealand mosses, *Bull. Roy. Soc. New Zealand* 5: 1–490 (1955); H.A.Miller, An overview of the Hookeriales, *Phytologia* 21: 243–252 (1971); C.M.Matteri, Revision de las Hypopterygiaceae (Musci) Austrosudamericanas, *Bol. Soc. Argent. Bot.* 15: 229–250 (1973); M.R.Crosby, Toward a revised classification of the Hookeriaceae (Musci), *J. Hattori Bot. Lab.* 38: 129–141 (1974); W.R.Buck, Taxonomic and nomenclatural arrangement in the Hookeriales with special notes on West Indian taxa, *Brittonia* 39: 210–224 (1987); W.R.Buck, Another view of familial delimitation in the Hookeriales, *J. Hattori Bot. Lab.* 64: 29–36 (1988); A.Whittemore & B.Allen, The systematic position of *Adelothecium* Mitt. and the familial classification of the Hookeriales (Musci), *Bryologist* 92: 261–271 (1989); J.D.Kruijer, Hypopterygiaceae of the World, *Blumea*, Suppl. 13: 1–388 (2002).

KEY TO GENERA

1 Stems usually simple, occasionally with a few innovations or a few distant branches, not differentiated into stipe and rachis, terete or quadrangular; sporophytes projecting beneath plane of gametophore .... **1. CYATHOPHORUM**

1: Stems branched, differentiated into stipe and rachis, terete; sporophytes projecting above plane of gametophore 2

  2 Plants pinnate to bipinnate; laminal leaf cells collenchymatous; walls incrassate; costa of lateral frond leaves percurrent or nearly so; setae mammillose; calyptra glabrous or with long paraphyses several cells wide *(1:)*... **3. LOPIDIUM**

  2: Plants usually palmate or umbellate, less often pinnate or flabellate; laminal leaf cells not collenchymatous; walls thin; costa of lateral frond leaves reaching 80% of leaf length at most; setae smooth; calyptra glabrous .... **2. HYPOPTERYGIUM**

1. CYATHOPHORUM

Cyathophorum P.Beauv., *Mag. Encycl.* 9, 5: 324 (1804); from the Greek *κυαθος* (*cyathos*, a cup) and *φορεω* (*phoreo*, to bear), in reference to the vaginula.

Hookeria Sm. sect. *Cyathophorum* (P.Beauv.) Arn., *Disp. Méth. Mousses* (preprint) 56 (1825 [1826?]); *Mém. Soc. Hist. Nat. Paris*, sér. 2, 2: 305 (1826); *Cyathophorum* P.Beauv. sect. *Eu-Cyathophorum* Broth., *Nat. Pflanzenfam.* I, 3: 966 (1907); *nom. illeg. pro Cyathophorum* P.Beauv. sect. *Cyathophorum*; *Cyathophonum* P.Beauv. ex Brid., *Muscol. Recent.*, Suppl. 4: 149 (‘1819’) [1818], *nom. inval., err. pro Cyathophorum* P.Beauv. T: *Cyathophorum pteridioides* P.Beauv., *nom. illeg. incl. spec. prior.* [*Anictangium bulbosum* Hedw.].

Stems usually simple, occasionally branched or with a few innovations, not differentiated, tomentose at the base and where creeping, terete or quadrangular; rudimentary branches absent; central strand present; axial cavities absent; axillary hairs absent or 4–11-celled. Foliation complanate. Leaves in 3 ranks; apex rounded or acuminate; costa forked or simple; laminal cells prosenchymatous, hexagonal, thin-walled. Calyptra mitrate, fleshy, pale to dark brown. Setae descending, straight to curved, ochraceous, smooth; base widened. Capsules erect, ochraceous to reddish ochraceous; rostrum straight. Exostome present; endostome at least partly ciliate; basal membrane reaching 33–50% of the exostome.

Cyathophorum comprises seven species in eastern Africa, Indo-Malaysia, warm-temperate parts of China and Japan, Melanesia, southern Polynesia (except New Caledonia), eastern Australia, and New Zealand. Represented in Australia by a single species.

Cyathophorum bulbosum (Hedw.) Müll.Hal., *Syn. Musc. Frond.* 2: 14 (1851)

Anictangium (*nom. rej.*) *bulbosum* Hedw., *Sp. Musc. Frond.* 43, t. 6, figs 1–5 (1801); *Hedwigia bulbosa* (Hedw.) Brid., *J. Bot. (Schrader)* 1: 272 ('1800') [1801]; *Anoectangium* (*nom. cons.*) *bulbosum* (Hedw.) Schwägr., *Sp. Musc. Frond.*, Suppl. 1, 1: 36 (1811); *Cyathophorum pteridioides* P.Beauv., *Mag. Encycl.* 9, 5: 324 (1804), *nom. illeg. incl. spec. prior.* [*Anictangium bulbosum* Hedw.]. T: "Insulae Australes", *collector unknown* (absent from the Hedwig-Schwägrichen herbarium in G, not located elsewhere); lecto: The illustrations in Hedwig (1801), *fide* J.D.Kruijer, *Blumea*, Suppl. 13: 24, 295 (2002).

Leskea pennata Labill., *Nov. Holl. Pl.* 2, 26: 106, t. 253, fig. 1 ('1806') [1807]; *Hookeria pennata* (Labill.) Sm., *Trans. Linn. Soc. London* 9: 277 (1808), *nom. illeg. incl. spec. prior.* [*Anictangium bulbosum* Hedw.]; *Pterigophyllum pennatum* (Labill.) Brid., *Muscol. Recent.*, Suppl. 4: 151 ('1819') [1818], *nom. illeg. incl. spec. prior.* [*Anictangium bulbosum* Hedw.]; *Cyathophorum pennatum* (Labill.) Brid., *Bryol. Univ.* 2: 722 (1827), *nom. illeg. incl. spec. prior.* [*Anictangium bulbosum* Hedw.]; *Hypnum pennatum* (Labill.) Poir., *in* Steudel, *Nomencl. Bot.* 2: 201 (1824), *nom. nud.* (in synon.) [*Hookeria pennata* (Labill.) Sm.]. T: "in capite van Diemen", [Tas.], *J.-J.H. de Labillardière*; type material not seen with certainty: BM?, FI?

Hookeria pennata (Labill.) Sm. var. *minor* Wilson & Hook.f., *in* J.D.Hooker & W.Wilson, *Fl. Antarct.* 1: 143, t. 62, fig. 3 (1844); *Cyathophorum pennatum* (Labill.) Brid. var. *minus* (Wilson & Hook.f.) Wilson, *in* J.D.Hooker, *Fl. Nov.-Zel.* 2: 120 ('1855') [1854]; *Cyathophorum bulbosum* (Hedw.) Müll.Hal. var. *minus* (Wilson & Hook.f.) Paris, *Index Bryol.* 294 (1894); *Cyathophorum pennatum* (Labill.) Brid. f. *minus* (Wilson & Hook.f.) Brizi, *Atti Reale Accad. Lincei, Rendicanti Cl. Sci. Fis.*, Ser. 5, 2: 103 (1893), as *minor*, *nom. nud.*; *Ann. Reale Ist. Bot. Roma* 6: 352 (1897), as *minor*; *Cyathophorum minus* (Wilson & Hook.f.) M.Fleisch., *Musc. Buitenzorg* 3: 1097 (1908), *nom. illeg. incl. spec. prior.* [*Cyathophorum densirete* Broth.]. T: "Lord Auckland's Islands" [Auckland Is.], *Antarct. Exp. 1839–43*, *J.D.Hooker s.n.*; holo: BM (sub *W 86.b*); iso: BR, FH, L, NY.

Cyathophorum densirete Broth., *Oefvers. Förh. Finska Vetensk.-Soc.* 35: 51 (1893), as *Cyatophorum*. T: South Road Forest, Circular Head, Tas., 21 Apr. 1892, *W.A.Weymouth 862*; holo: H *n.v.*; iso: BM, JE, NY.

Illustrations: B. & N.Malcolm, *Mosses and other Bryophytes* 10, 37, 71, 152, 203 (2000); J.D.Kruijer, *Blumea*, Suppl. 13: 50, pl. 3D; 298, fig. 46; 306, fig. 48B; 308, fig. 49B (2002); W.R.Buck, D.H.Vitt & W.M.Malcolm, *Key to the Genera of Australian Mosses* 36 (2002).

Dioicous. Plants occasionally gemmiferous. Stems to 6 (–12) cm tall, usually quadrangular in section, occasionally weakly terete; terminal cell of axillary hairs ±rectangular, elongate to linear, 55–95 × 8–15 µm, smooth. Leaves dull or glossy; margin usually serrate-dentate, rarely ciliate; teeth 1–7-celled, to 150 (–400) µm long; border absent or interrupted; costa reaching 16–50% of lamina length; laminal cells 45–205 × 20–50 µm. Lateral leaves ovate to lanceolate, 3.0–10.5 mm long, 1–4 mm wide; amphigastria round to oblong, 1–4 mm long, 0.5–4.0 mm wide. Calyptra 0.4–0.6 mm long. Setae 0.8–3.0 mm long. Capsules subglobose to ellipsoidal, 1.2–2.3 mm long, 1.0–1.3 mm wide; operculum long-rostrate, 0.8 mm long. OPL: PPL: IPL = 4: 2: 4–8(–10)c. Exostome teeth 290–510 µm long, 70–140 µm wide. Spores 10–25 µm. $n = 5$, based on material from Vic. and New Zealand, *fide* H.P.Ramsay, *in* A.Löve, *Taxon* 16: 559 (1967); M.E.Newton, *J. Bryol.* 7: 399, 400 (1973); H.P.Ramsay, *Austral. J. Bot.* 22: 327, 328 (1974). Plates 59, 60.

Occurs in Qld, N.S.W., Vic., Tas. and south-eastern S.A. at elevations up to 1670 m; also in Papua New Guinea, New Zealand, Auckland Is., Chatham Is., Lord Howe Is. and perhaps on Norfolk Is. and New Ireland. Grows on soil, rock (basalt, sandstone, granite and limestone), rotting logs or stem bases and the trunks of trees and tree ferns; less often on branches of trees, rarely found submerged in streams near the water-line, in forests and fern thickets, frequently in moist, shaded places, especially in gullies and near streams. Map 233.

S.A.: Mt Gambier, *F.Mueller s.n.* (MEL). Qld: Mt Bellenden Ker, *H.Streimann 27380* (CANB). N.S.W.: Nadgee State Forest, *H.Streimann 38062* (CANB). Vic.: Mount Napier State Park, *A.C.Beauglehole 3881* (MEL). Tas.: Tasman Penin., 3 Feb. 1899, *W.A.Weymouth s.n.* (CANB, NY).

Most plants are shorter than 6 cm; larger ones are known from Vic. and Tas., and plants more than 7.5 cm in length were found only in Vic. Plants from Qld lack gemmae and have leaves that are predominantly set with unicellular teeth, while southern specimens are occasionally gemmiferous and show a predominance of multicellular teeth at their leaf margins. In all areas most stems are simple, but undamaged, branched stems do occur and may be found more frequently in nature than are known from herbarium material. Damaged stems frequently have a few innovations, and those growing in particularly wet conditions are occasionally dark olive-green. The axillary hairs are especially difficult to observe and, in addition, they are often damaged or lost.

Fruiting specimens were frequently found in Vic. and Tas., but these are uncommon elsewhere in Australia.

Labillardière (*loc. cit.*) and Palisot de Beauvois (*Mém. Soc. Linn. Paris* 1: pl. 8, fig. 6, 1822) depicted completely non-ciliate endostomes of *Cyathophorum bulbosum*. However, the endostomes are usually entirely ciliate, although partly non-ciliate endostomes are sometimes seen.

Doubtful Records

Canalohypopterygium tamariscinum (Hedw.) Kruijer, *Lindbergia* 20: 87 (1996)

Leskea tamariscina Hedw., *Sp. Musc. Frond.* 212, t. 51, figs 1–7 (1801). T: "Insulae Australes & Jamaica" (Jamaican material excluded), unknown collector (absent from the Hedwig-Schwägrichen herbarium in G, not located elsewhere); lecto: The illustrations in Hedwig (1801), *fide* H.Kruijer, *Lindbergia* 20: 85–88 (1996).

Hypnum setigerum P.Beauv., *Prodr.* 70 (1805); *Hypopterygium setigerum* (P.Beauv.) Wilson, *in* J.D.Hooker, *Fl. Nov.-Zel.* 2: 118 ('1855') [1854], *nom. illeg. incl. spec. prior*. (*Leskea tamariscina*), *fide* H.Kruijer, *Lindbergia* 20: 85–88 (1996).

Hypopterygium commutatum Müll.Hal., *Syn. Musc. Frond.* 2: 6 (1850), *nom. illeg. incl. spec. prior.*; *Canalohypopterygium commutatum* (Müll.Hal.) Frey & Schaepe, *J. Hattori Bot. Lab.* 66: 269 (1989), *nom. illeg. incl. spec. prior*. (*Leskea tamariscina*), *fide* H.Kruijer, *Lindbergia* 20: 85–86 (1996).

Reported for mainland Australia and Tasmania by Sainsbury (1955, as *Hypopterygium setigerum*), but almost certainly endemic to New Zealand. G.A.M.Scott & I.G.Stone (*The Mosses of Southern Australia* 398, 1976, as *H. commutatum*) found no records of *C. tamariscinum* for Australia, likewise Kruijer (2002). The few herbarium specimens of *C. tamariscinum* said to come from Australia or Tasmania proved to be misidentified or are almost certainly mislabelled.

Catharomnion ciliatum (Hedw.) Wilson, *in* J.D.Hooker, *Fl. Nov.-Zel.* 2: 119 ('1855') [1854]

Pterigynandrum ciliatum Hedw., *Sp. Musc. Frond.* 84, t. 17, figs 7–13 (1801). T: "Insulae Australes", unknown collector (absent from the Hedwig-Schwägrichen herbarium in G, not located elsewhere); lecto: The illustrations in Hedwig (1801), *fide* J.D.Kruijer, *Blumea* Suppl. 13: 131 (2002).

Reported from mainland Australia and Tasmania, but almost certainly confined to New Zealand and Chatham Is. Rodway (1914) and Sainsbury (*Pap. & Proc. Roy. Soc. Tasmania* 90: 37, 1956) suggested that the Tasmanian record was erroneous. Kruijer (2002) suggested that Tasmanian records made by various authors in the Australian and New Zealand literature were based on almost certainly mislabelled material gathered by R.C.Gunn. Gunn's collections are the only ones that are indicated to come from Tasmania, and they probably originated in New Zealand.

Hampe (in F.Mueller, *Fragm*. 11 (Suppl.): 52, 1880) reported the species from mainland Australia based on collections made by F.Mueller, but these collections were not found (Kruijer, 2002).

Dendrohypopterygium filiculiforme (Hedw.) Kruijer, *Blumea*, Suppl. 13: 105 (2002)

Leskea filiculiformis Hedw., *Sp. Musc. Frond.* 212, t. 50, figs 1–5 (1801), as *filiculaeformis*; *Hypopterygium filiculiforme* (Hedw.) Brid., *Bryol. Univ.* 2: 712 (1827). T: "Insulae Australes", *collector unknown* (absent from the Hedwig-Schwägrichen herbarium in G); lecto: the illustrations in Hedwig (1801), *fide* J.D.Kruijer, *Blumea*, Suppl. 13: 24, 105 (2002).

This moss has not been reported from Australia in the literature, and it is almost certainly endemic to New Zealand. The few specimens that are labelled as coming from Australia (and Norfolk Is.) are presumed to have been mislabelled (Kruijer, 2002). Four specimens in BM collected by Ludwig Leichardt are labelled "Australia & New Zealand", but they were probably collected in New Zealand.

2. HYPOPTERYGIUM

Hypopterygium Brid., *Bryol. Univ.* 2: 709 (1827); from the Greek *ύπο* (*hypo*-, under) and *πτερυγιον* (*pterygion*, a little wing), in reference to the amphigastria.

Hypopterygium Brid. sect. *Euhypopterygium* Müll.Hal., *Syn. Musc. Frond.* 2: 3 (1850), *nom. illeg.* [*Hypopterygium* Brid. sect. *Hypopterygium*]; *Hypopterygium* Brid. subg. *Euhypopterygium* Bosch & Sande Lac., *Bryol. Jav.* 2: 10 (1861), *nom. illeg.* [*Hypopterygium* Brid. subg. *Hypopterygium*]; *fide* R. van der Wijk *et al.* (*Index Musc.* 3: 178, 1964), based on *Hypopterygium* Brid. sect. *Euhypopterygium* Müll.Hal. Lecto: *Hypopterygium laricinum* (Hook.) Brid. [= *Hypopterygium tamarisci* (Sw.) Brid. ex Müll.Hal.].

Hypopterygium Brid. sect. *Pseudotamariscina* Kindb., *Hedwigia* 40: 285 (1901), as *Pseudo-Tamariscina*; *Hypopterygium* Brid. subsect. *Pseudotamariscina* (Kindb.) M.Fleisch., *Musc. Buitenzorg* 3: 1080 (1908), as *Pseudo-Tamariscina*. T: *Hypopterygium tasmanicum* Kindb. [= *H. didictyon* Müll.Hal.].

Hypopterygium Brid. subg. *Euhypopterygium* Kindb., *Hedwigia* 40: 284 (1901), *nom. illeg.*; *Hypopterygium* Brid. sect. *Euhypopterygium* (Kindb.) M.Fleisch., *Musc. Buitenzorg* 3: 1080 (1908), *nom. illeg.*, incl. type of *Hypopterygium* Brid., *fide* J.D.Kruijer, *Blumea*, Suppl. 13: 139 (2002).

Hypopterygium Brid. sect. *Tamariscina* Kindb., *Hedwigia* 40: 287 (1901), *nom. illeg.*; *Hypopterygium* Brid. subsect. *Tamariscina* (Kindb.) M.Fleisch., *Musc. Buitenzorg* 3: 1083. (1908), *nom. illeg.*, incl. type of *Hypopterygium* Brid., *fide* J.D.Kruijer, *Blumea*, Suppl. 13: 139 (2002).

Plants pinnate to umbellate. Stipe tomentose or glabrous above base. Frond transversely (ob-) ovate to elliptic, glabrous (partly tomentose in one species); ramification pinnate to bipinnate (or partly tripinnate); rudimentary branches absent; axes terete; central strand present; axial cavities absent; axillary hairs 2–4-celled. Foliation partly or entirely complanate. Leaves in 3, 8 or 11 (or rarely more) ranks at stipe and in 3 ranks at rachis and branches, dull or slightly glossy; costa simple, reaching 67–80% the length of the lateral leaves, one-third to excurrent in amphigastria; laminal cells prosenchymatous (partly parenchymatous in one species), hexagonal, thin-walled. Calyptra cucullate, white to ochraceous, glabrous, partly membranous, partly fleshy. Setae ascending to erect, straight to uncinate, ochraceous to (reddish) brown, smooth; base narrow. Capsules cernuous to pendulous, ochraceous or brown; rostrum oblique. Exostome present; endostome ciliate; basal membrane reaching 30–50% of the length of the exostome.

A genus of seven species in mainly humid, tropical and subtropical regions of both hemispheres; also in warm-temperate regions of the Southern Hemisphere and East Asia and along the western and north-eastern coasts of the Pacific Ocean. Represented in Australia by three non-endemic species.

T.Pfeiffer, J.D.Kruijer, W.Frey & M.Stech, Systematics of the *Hypopterygium tamarisci* complex (Hypopterygiaceae, Bryopsida): implications of molecular and morphological data. Studies in austral temperate rain forest bryohytes 9, *J. Hattori Bot. Lab.* 89: 55–70 (2000).

1 Stipe and basal frond leaves in 8 ranks; dorsal leaves present in basal part of rachis; laminal cells parenchymatous to prosenchymatous, rectangular or hexagonal; terminal cell of axillary hairs usually short-linear to linear, smooth or covered with white substances (cells with white substances visible as white dots with hand lens)........ **1. H. didictyon**

1: Stipe and basal frond leaves in 3 or 11 (or more) ranks; dorsal leaves absent; laminal cells prosenchymatous, hexagonal; terminal cell of axillary hairs short to elongate, never short-linear or linear, smooth or weakly covered with white substances (only visible with light microscope)........ 2

2 Dioicous; plants usually strongly palmate to umbellate, rarely flabellate, not gemmiferous; stipe frequently more than 15 mm long; distal frond leaves weakly to coarsely serrate-dentate, not caducous; teeth usually more than 20; border green *(1:)*........ **2. H. discolor**

2: Monoicous or dioicous; plants pinnate to bipinnate (or partly tripinnate), palmate or umbellate, gemmiferous or not; stipe less than 15 mm long; distal frond leaves entire or weakly serrate to weakly serrate-dentate, occasionally caducous in palmate to umbellate plants; teeth fewer than 20; border colourless .... **3. H. tamarisci**

1. **Hypopterygium didictyon** Müll.Hal., *Syn. Musc. Frond.* 2: 9 (1850)

Hypopterygium didyctium Müll.Hal. ex Berthier, *Rev. Bryol. Lichénol.* 38: 546 ('1971–72') [1972], *nom. illeg. orthogr. err. pro H. didictyon* Müll.Hal. T: Hermite Island, Cape Horn, Magellanes Prov., Chile, *J.D.Hooker s.n.*, *Antarct. Exped. 1839–43*; holo: B (destroyed); lecto: L, *fide* J.D.Kruijer, *Blumea*, Suppl. 13: 144 (2002); isolecto: BM (*s.n.*, sub nos *163* and *W. 154*), E (*n.v.*), H (*n.v.*), S (sub nos *23* and *24* in Herb. Kindberg), TDC.

Hypopterygium novaeseelandiae Müll.Hal., *Bot. Zeitung (Berlin)* 9: 562 (1851), as *novae-seelandiae*. T: "ad corticem arborum dejectarum sylvarum prope Kaipara" [(Wairoa) Forests, Kiapara Harbour], North Island, New Zealand, 1850, *S.Mossman 722*; holo: B (destroyed), lecto: NY, *fide* J.D.Kruijer, *Blumea*, Suppl. 13: 144 (2002); isolecto: BM (sub no. *22*, which is probably an error for no. *722*), JE? (*s.n.*, *s. loc.*).

Hypopterygium smithianum Hook.f. & Wilson, *in* J.D.Hooker, *Fl. Nov.-Zel.* 2: 118 ('1855') [1854]; *H. smithii* Wilson ex Kindb., *Enum. Bryin. Exot.* 20 (1888), *nom. illeg. orthogr. err. pro H. smithianum* Hook.f. & Wilson]. *Hookeria rotulata auct. non* Hedw.: J.E.Smith, *Trans. Linn. Soc. London* 9: 279 (1808); according to Hooker & Wilson, *in* J.D.Hooker, *Fl. Nov.-Zel.* 2: 118 ('1855') [1854]; J.E.Smith (*loc. cit.*) identified a plant from New Zealand collected by A.Menzies which was almost certainly a syntype of *H. smithianum*. T: "Dusky Bay" [Dusky Sound], South Island, New Zealand, 1791, *A.Menzies 74*; lecto: BM, *fide* J.D.Kruijer, *Blumea* Suppl. 13: 144 (2002); isolecto: BM; Bay of Islands, North Island, New Zealand, *A.Cunningham* "etc."; syn: not located; East Coast and interior, North Island, New Zealand, *W.Colenso s.n.*; syn: not located with certainty, probably *W.Colenso 2535*, BM (*s. loc.*) and *W.Colenso 2560*, BM (*s. loc.*); East Coast and interior, North Island, New Zealand, *J.Sinclair s.n.*; syn: not located with certainty, possibly the original material of *H. pallidisetum* Wilson, *nom. nud.* (in synon.), in BM; Port William, Stewart Island, [New Zealand], 1850, *D.Lyall 80*; syn: BM.

Hypopterygium glaucum Sull., *Proc. Amer. Acad. Arts* 3: 184 (1855); *H. novaeseelandiae* Müll.Hal. var. *glaucum* (Sull.) Dixon, *Bull. New Zealand Inst.* 3(5): 295 (1927); *H. novaeseelandiae* Müll.Hal. f. *glaucum* (Sull.) Vitt, *New Zealand J. Bot.* 12: 205 (1974). T: New Zealand, *U.S. Exploring Exped. Wilkes 1838–42*; holo: FH? (not located); iso: BM, NY.

Hypopterygium tasmanicum Müll.Hal. ex Kindb., *Hedwigia* 40: 285. (1901). T: Tas., May 1890, *Bochard s.n.*; holo: S (sub no. *12*); iso: B (destroyed).

Illustrations: K.W.Allison & J.Child, *Mosses of New Zealand* pl. 29 (1971); C.M.Matteri, *Bol. Soc. Argent. Bot.* 15: 242, pl. 3 (1973); J.D.Kruijer, *Blumea*, Suppl. 13: 147, fig. 16; 148, fig. 17 (2002).

Dioicous. Plants palmate or umbellate, not gemmiferous. Stipe to 15 mm long, tomentose, glabrous when young. Frond to 3.5 cm wide, glabrous or partly tomentose; branches not caducous; terminal cell of axillary hairs usually rectangular, rarely elliptic, elongate to short-linear to linear, 40–95 × 5–15 µm, smooth or covered with a white substance. Stipe leaves in 8 ranks. Frond leaves in 8 ranks in the basal part of the rachis, in 3 ranks in the distal part of the frond, transverse-ovate to oblong, (0.2–) 0.5–2.0 mm long, 0.2–1.5 (–2.0) mm wide; distal ones occasionally caducous; margin entire to coarsely serrate-dentate; teeth 1-celled, to 20 µm long; border entire, colourless; laminal cells 20–95 × 5–30 µm. Calyptra 2.7–3.9 mm long. Setae 12–18 mm long. Capsules ellipsoidal, 1.1–2.4 mm long, 0.7–1.5 mm wide; operculum 2.0–2.5 mm long. OPL: PPL: IPL = 4: 2: 6–8c. Exostome teeth (440?–) 630–640 µm long, (120–) 140–160 µm wide. Spores 9–16 µm. $n = 6$, *fide* M.E.Newton, *J. Bryol.* 7: 399, 400 (1973), as *H. novae-seelandiae*.

Occurs in N.S.W., Vic. and Tas. and rare in S.A; at elevations up to 1660 m. Also in New Zealand, Auckland Is.; Campbell Is., Chatham Is. and southern South America; doubtfully in Norfolk Is. Grows on soil, rocks, rotting logs and tree trunks in forest and scrubby woodland, frequently near streams and in humid habitats. Map 234.

S.A.: Mt Gambier, *Wilhelmi s.n.* (BM, RO). N.S.W.: White Rock Mtn, *J.H.Willis s.n.* (MEL). Vic.: Errinundra R., *H.Streimann 36592* (B, CANB, NY). Tas.: Mt Wellington, *R.A.Bastow 147* (MEL, NSW); Wylds Craig, *D.A. & A.V.Ratowsky B44e* (CANB, GRO, NY).

The collection from S.A. (BM and RO) is credited to F.Mueller, but it was probably collected by Wilhelmi (*fide* E.Hampe, *Linnaea* 28: 215, 1856).

Fruiting specimens were frequently found.

This species was included in G.A.M.Scott & I.G.Stone's (*The Mosses of Southern Australia* 396, 1976) circumscription of *H. rotulatum*.

2. Hypopterygium discolor Mitt., *in* J.D.Hooker, *Handb. New Zealand Fl.* 2: 488 (1867)

T: "Wairoa forests Kiapara" [Kiapara Harbour], North Island, New Zealand, *S.Mossman s.n.*; lecto: NY, *fide* J.D.Kruijer, *Blumea*, Suppl. 13: 163 (2002); Auckland, North Island, New Zealand, *C.Knight s.n.*; syn: not located; (excluded from syntypes: Auckland, North Island, New Zealand, *Jupp s.n.* NY [= *H. didictyon* Müll.Hal.]).

Hypopterygium scottiae Müll.Hal., *Linnaea* 35: 619 (1868). T: "Ash Island ad or. flum. Hunter [Hunter R.] litor. orient. Novae Hollandiae", N.S.W., *H.Scott s.n.*; syn: B (destroyed); lecto: BM; *fide* J.D.Kruijer, *Blumea*, Suppl. 13: 163 (2002); isolecto: NY; Brisbane River, "Austral. or. aeq." [Qld], *A.Dietrich s.n.* syn: B (destroyed); isosyn: BM, BM ("1864"), JE, JE ("1865"), MEL (sub no. *451*), NY, W.

Illustrations: J.D.Kruijer, *Blumea*, Suppl. 13: 164, fig. 20; 166, fig. 21 (2002).

Dioicous. Plants palmate to umbellate (rarely flabellate), rarely gemmiferous. Stipe to 30 mm long, tomentose at base; stipe leaves in 3 ranks (rarely 11 ranks in basal third of stipe). Frond to 3.5 cm wide, glabrous; branches not caducous; terminal cell of axillary hairs elliptic to rectangular, short to elongate, 30–70 × 10–30 µm, smooth or weakly covered with a white substance. Frond leaves in 3 ranks, transverse-ovate to elliptic, 0.5–1.5 mm long, 0.5–1.5 mm wide, persistent; margin (entire to) coarsely serrate-dentate; teeth 1 (or 2)-celled, to 40 µm long; border entire, green; laminal cells 15–60 × 15–25 µm. Calyptra 2.0–2.5 (–3.0) mm long. Setae 9–40 mm long. Capsules barrel-shaped to narrowly ellipsoidal, 1.4–2.0 (–2.5) mm long, 0.9–1.5 mm wide; operculum 1.5–2.0 mm long. OPL: PPL: IPL = 4: 2: 6–10c. Exostome teeth 540–640 µm long, 125–160 µm wide. Spores 10–15 µm.

Occurs in coastal areas of eastern Qld and N.S.W. at elevations up to 330 m. Grows mainly on sandy soil in riverine rainforest, monsoon forest with a dense shrubby understorey and dry monsoon scrub, most frequently in shade, and near streams or in other damp places. Also in New Zealand (North Island), but not collected there since the nineteenth century. Map 235.

Qld: Bundaberg, *H.Smithurst 270* (MEL, NSW); Fraser Is., *C.Borough 4* (CANB, L). N.S.W.: Ballina, *W.W.Watts 3412* (NSW).

A report from Mt Gambier, S.A. (W.Mitten, *Trans. & Proc. Roy. Soc. Victoria* 19: 76, 1882) could not be verified. However, it was presumably based on a misidentification of *H. tamarisci* or *H. didictyon*. An erroneous report from Tasmania (H.W.Lett, *J. Bot.* 42: 252, 1904) was based on a misidentification of *H. tamarisci*.

Gemmiferous plants are rare and are usually damaged, while fruiting specimens are common in most collections with female plants.

3. Hypopterygium tamarisci (Sw.) Brid. ex Müll.Hal., *Syn. Musc. Frond.* 2: 8 (1850)

Hypnum tamarisci [Sw. ex] Sw., *Fl. Ind. Occid.* 3: 1825 (1806); Sw., *Prodr*. 141 (1788), *nom. inval*. (pre-starting point); *Hookeria arbuscula* Arn., *Disp. Méth. Mousses* (preprint) 56 (1825 [1826?]); *Mém. Soc. Hist. Nat. Paris*, sér. 2, 2: 305 (1826), *nom. illeg.* (later homonym), *non* Sm., *Trans. Linn. Soc. London* 9: 280, t. 23, fig. 3 (1808) [= *Camptochaete arbuscula* (Sm.) Reichardt]. T: Jamaica, *O.Swartz s.n.*; holo: UPS *n.v*.; iso: G, S, W (damaged).

Hypopterygium rotulatum (Hedw.) Brid. var. *incurvum* Brid., *Bryol. Univ.* 2: 714 (1827). T: "Nova Hollandia" [Australia], 1822; holo: B, ex Herb. A.P. de Candolle, *s. coll.*; iso: JE, ex Herb. Bridel, *s. coll.*, *s. dat.*

Hypopterygium tenellum Müll.Hal., *Bot. Zeitung (Berlin)* 12: 557 (1854); *H. rotulatum auct. non* Hedw.: Montagne, *Ann. Sci. Nat. Bot.*, sér. 2, 17: 243 (1842), *fide* C.Müller, *Bot. Zeitung (Berlin)* 12: 558 (1854); *H. rotulatum* Mont. ex Okamura, *J. Coll. Sci. Imp. Univ. Tokyo* 36, 7: 25 (1915), *nom. nud*. (in synon.). [*Hypopterygium tenellum* Müll.Hal.]; given as a synonym, but probably meant as a misidentification. T: Nilgiri Hills, Tamil Nadu, India, *Schmid s.n.*; lecto: JE, *fide* T.Pfeiffer *et al.*, *J. Hattori Bot. Lab.* 89: 65–66 (2000); isolecto: B (destroyed), BM, NY; Nilgiri Hills, Tamil Nadu, India, *Perrottet s.n.*; syn: B (destroyed), BM.

Hypopterygium muelleri Hampe, *Linnaea* 28: 215 (1856); *Pterobryon muelleri* (Hampe) Mitt., *Trans. & Proc. Roy. Soc. Victoria* 19: 81 (1882). T: "In lapidibus ad ripam fluminis Buchan humidam" [Buchan R.], Vic., Mar. 1854, *F.Mueller s.n.* holo: BM (not located); holo?: MEL, *fide* J.D.Kruijer, *Glasgow Naturalist* 23(2): 16 (1997), sub no. *40*; iso: MEL, WELT, both sub. nos *40* and *111*. Types of *Hypopterygium muelleri* are absent from E.Hampe's herbarium (BM) and were not located in other herbaria, except for two specimens in MEL and one in Sainsbury's herbarium in WELT; see also T.Pfeiffer *et al.*, *J. Hattori Bot. Lab.* 89: 68 (2000). The potential holotype is provided with annotations by E.Hampe. There is no evidence that another specimen from Buchan R. (in TDC) belongs to the type material, because its collector is unknown.

Hypopterygium viridulum Mitt., *in* J.D.Hooker, *Handb. New Zealand Fl.* 2: 487 (1867). T: Akaroa, Banks Penin., Canterbury, "Middle Island" [South Island], New Zealand, *Kerr s.n.*; lecto: NY, *fide* J.D.Kruijer, *Blumea*, Suppl. 13: 200 (2002); Wellington, North Island, New Zealand, *Stephenson s.n.*; syn: not located with certainty; Wangaroa, North Island, New Zealand, *Kerr s.n.*; syn: not located; New Zealand, *Stephenson 11b*; syn?: NY; New Zealand, *Stephenson 20*; syn?: BM; NY.

Hypopterygium rigidulum Mitt. subsp. *balantii* Müll.Hal. ex Kindb., *Hedwigia* 40: 295 (1901); *H. rigidulum* Mitt. var. *balantii* Kindb. ex Streimann & J.Curn., *Austral. Fl. & Fauna Ser.* 10: 213 (1989), *nom. inval., err. pro H. rigidulum* Mitt. subsp. *balantii* Müll.Hal. ex Kindb. T: Botanical Garden of Berlin: palm house of the "Flora", Charlottenburg, Berlin, Germany, "ad truncum *Balantii antarctii*", 13 Nov. 1885, *H.Graef s.n.*; lecto: S, *fide* J.D.Kruijer, *Glasgow Naturalist* 23(2): 16 (1997) (sub. nos *45* and *33* in Herb. Kindberg); isolecto: B (destroyed), JE; Botanical Garden of Berlin: palm house of the "Flora", Charlottenburg, Berlin, Germany, "ad truncum [putrid.?] *Balantii antarctii*", Nov. 1888, *H.Graef s.n.*; syn: B (destroyed); S (sub. nos *45* and *33* in Herb. Kindberg), JE.

Hypopterygium scottiae Müll.Hal. subsp. *denticulatum* Kindb., *Hedwigia* 40: 296 (1901). T: Toowoomba, Qld, but erroneously presented as being located in "Van Diemensland" [Tas.], [*C.*]*H.Hartmann s.n.*, "distr. Rehmann n. *20*"; holo: S.

Illustrations: F.M.Bailey, *Compr. Cat. Queensland Pl.* 665, fig. 635 (1913); J.D.Kruijer, *Blumea*, Suppl. 13: 48, pl. 2e & f; 210, fig. 29; 211, fig. 30; 212, fig. 31; 213, fig. 32; 214, fig. 33; 220, fig. 34 (2002); H.Streimann, *The Mosses of Norfolk Island* 103, fig. 47; 105, pl. 20 (2002).

Dioicous or monoicous and unisexual or (in part) bisexual. Plants pinnate to palmate or umbellate, gemmiferous or not. Stipe to 15 mm long, tomentose at base. Frond to 3.5 cm wide, glabrous; branches caducous or not; terminal cell of axillary hairs suborbicular to elliptic, short to oblong (or elongate), 20–75 × 10–30 µm, smooth. Stipe leaves in 3 or 11 (or more) ranks. Frond leaves in 3 ranks, transversely elliptic to ovate or elliptic, (0.1–) 0.7–1.2 mm long, (0.1–) 0.3–1.0 mm wide; distal ones occasionally caducous; margin entire to weakly (or coarsely) serrate-dentate; teeth 1-celled, to 15 (–30) µm long; border entire, colourless; laminal cells 20–60 × 10–25 µm. Calyptra 1.5–2.5 mm long. Setae 4.0–14.5 mm long. Capsules ovoid to ellipsoidal or urceolate, 1.3–2.3 mm long, 0.7–1.2 mm wide; operculum 1.3–1.8 mm long. OPL: PPL: IPL = 4: 2: 6(–8)c. Exostome teeth 360–630 µm long, 105–130 µm wide. Spores 12–17 µm. n = 9, 18, c. 27 and 36, based on material from Mt Wilson, N.S.W., *fide* H.P.Ramsay, *Proc. Linn. Soc. New South Wales* 91: 220–230 (1967), as *H. rotulatum* (Hedw.) Brid. Plates 61–63.

Occurs in S.A., Qld, N.S.W., A.C.T., Vic. and Tas.; also in Lord Howe Is. and Norfolk Is.; a widespread pantropical and warm-temperate species. Grows on rocks (basalt, limestone and sandstone), the trunks of trees and palms, tree ferns, less often on rotting logs, vines and climbers, or on soil, usually in dry to wet forests, frequently near streams, in moist or wet places, or in semi-shaded and shaded habitats. Found at altitudes up to 1660 m, but only to 480 m in Vic. and Tas. Map 236.

S.A.: Naracoorte Caves, *A.J.Downing 0944* (MACQ). N.S.W.: Cann Valley Hwy, *H.Streimann 058506* (L). A.C.T.: Tidbinbilla Nature Reserve, *H.Streimann 1065* (B, CANB). Vic.: Mt Drummer, *D.Verdon 1253* (L). Tas.: St. Marys, *J.Curnow 2448* (CANB).

In Qld and north-eastern N.S.W. plants smaller than 1.5 cm predominate at every altitude, and medium-sized plants occur mostly at 500–1000 m; plants larger than 4.5 cm are rare. In south-eastern N.S.W., Vic. and Tas. small and medium-sized plants are almost equally abundant at all elevations.

Almost every plant has entire, weakly serrate or serrate-dentate leaves, but the frond leaves of a few plants from two localities near Proserpine, Qld are moderately to coarsely (serrate to) serrate-dentate. These plants did not grow under exceptional conditions.

The species shows considerable morphological variation across its global range. Regional and some ecological variation is especially noticeable in life form, size, sexuality and the presence or absence of propagules. Two informal variants of *H. tamarisci* can be recognised in Australia (Pfeiffer *et al.*, 2000; Kruijer, 2002). These are not sharply defined, and intermediates frequently occur in every part of the distributional range of the species.

'*Australasian*' *variant*: Monoicous (or dioicous). Plant (pinnate to) palmate or umbellate, frequently gemmiferous. Costa of frond amphigastria reaching 33–67% of amphigastrium length (to excurrent). Branches occasionally caducous. Equally frequent on rocks and as an

epiphyte, less common on soil and rotting logs. Distribution: Qld, N.S.W., A.C.T., Vic., Tas., Lord Howe Is., Norfolk Is., New Zealand, New Caledonia.

'*Australian*' *variant*: Dioicous. Plant pinnate to bipinnate (or partly tripinnate), not gemmiferous. Costa of frond amphigastria reaching 67% of amphigastrium length to excurrent. Branches not caducous. Most frequent on rocks, less common on soil, rotting logs and as an epiphyte. Distribution: Qld, N.S.W., A.C.T., Vic., Tas.

The 'Australasian' variant predominates in Qld and north-eastern N.S.W. The variants have equal occurrence in south-eastern N.S.W. and Vic., and the species is rare in Tas.

Doubtful Species

Hypopterygium rotulatum (Hedw.) Brid., *Bryol. Univ.* 2: 713 (1827)

Leskea rotulata Hedw., *Sp. Musc. Frond.* 213, t. 51, figs 8–13 (1801). T: "Insulae meridionales", *coll. unknown* [absent from the Hedwig-Schwägrichen herbarium in G; not located elsewhere]; lecto: The illustrations in Hedwig (1801), *fide* J.D.Kruijer, *Blumea*, Suppl. 13: 250 (2002).

Hedwig's description and illustrations of *H. rotulatum* do not differentiate this taxon from other *Hypopterygium* species, and they have caused considerable confusion (Kruijer, 2002). Specimens from Australia that had been identified as *H. rotulatum* proved to be either *H. didictyon* or *H. tamarisci*. H.N.Dixon's (*Bull. New Zealand Inst.* 3(5): 296, 1927) *H. rotulatum* agrees with *H. tamarisci*. Reports of *H. rotulatum* in G.A.M.Scott & I.G.Stone (*The Mosses of Southern Australia* 396, 1976) are referable to *H. didictyon* and *H. tamarisci*.

3. LOPIDIUM

Lopidium Hook.f. & Wilson, *in* J.D.Hooker, *Fl. Nov.-Zel.* 2: 119 ('1855') [1854]; from the Greek *λοπίς* (*lopis*, a scale); the authors did not give any reference or indication as to which part of the plant they had in mind when they invented the name *Lopidium* for their new genus.

Hypopterygium subg. *Lopidium* (Hook.f. & Wilson) Bosch & Sande Lac., *Bryol. Jav.* 2: 8 (1861); *Hypopterygium* sect. *Lopidium* (Hook.f. & Wilson) Mitt., *J. Linn. Soc., Bot.* 12: 329 (1869); *Lophidium* Brid. ex Rodway, *Pap. & Proc. Roy. Soc. Tasmania* 1913: 237 (1914), *nom. illeg. incl. gen. prior., err. pro Lopidium* Hook.f. & Wilson.

Lecto: *L. concinnum* (Hook.) Wilson.

Plants pinnate to bipinnate, occasionally tripinnate, flabellate or weakly dendroid, rarely simple. Stipe tomentose at base. Frond rhomboidal to ovate to shortly linear-elliptic, glabrous; rudimentary branches absent; axes terete; central strand present or absent; axial cavities present or absent; inclusions colourless to olivaceous or reddish brown; axillary hairs 2–4-celled. Foliation complanate except for the stipe base and innovations (occasionally not complanate in *L. concinnum*). Leaves in 3 ranks, dull; apex obtuse or acute or acuminate; costa simple, nearly percurrent to excurrent; laminal cells collenchymatous, isodiametric, transversely hexagonal or hexagonal; walls incrassate. Calyptra cucullate, white, pale ochraceous or partly brown, glabrous or set with paraphyses, partly membranous, partly fleshy. Setae horizontal or ascending, straight to uncinate, ochraceous to brown, mammillose. Capsules erect to pendulous, ochraceous to brown; rostrum oblique. Exostome present; endostome not ciliate or rudimentary-ciliate by 1 (or 2) plates; basal membrane reaching no more than one-third the length of the exostome.

A genus of two species, both of which occur in Australia. *Lopidium struthiopteris* occurs mainly in the Palaeotropics, while *L. concinnum* is a (warm-) temperate species of the Southern Hemisphere. Species show great variability in the size of the plant, the length of the stipe, rachis and branches, and the degree of ramification and the number of branches, a character that has a considerable impact on the shape of the frond.

Gemmae always absent; monoicous; paraphyses absent or present in mature perichaetia, never extending; exostome teeth at least 70 µm wide; calyptra glabrous ....**1. L. concinnum**

Gemmae present; dioicous; paraphyses present in mature perichaetia, frequently longer than perichaetial leaves; exostome teeth less than 70 µm wide; calyptra set with paraphyses .... **2. L. struthiopteris**

1. Lopidium concinnum (Hook.) Wilson, *in* J.D.Hooker, *Fl. Nov.-Zel.* 2: 119 (‘1855’) [1854]

Leskea concinna Hook., *Musci Exot.* 1: t. 34 (1818); *Hookeria concinna* (Hook.) Hook. & Grev., *Edinburgh J. Sci.* 2: 232 (1825); *Hypopterygium concinnum* (Hook.) Brid., *Bryol. Univ.* 2: 711 (1827). T: “Dusky Bay” [Dusky Sound], South Island, New Zealand, 1791, *A.Menzies s.n.*; holo: BM (sub nos *84* and *H. 1529a*); iso: BM (fragments sub no. *H. 1529b*), G? (*n.v.*), S; iso?: NY (Herb. Mitten, *s. loc.*). Several annotations in Wilson’s herbarium attached to the specimens with the number *H. 1529b* refer to them as original specimens and duplicates of the holotype.

Lopidium pallens Hook.f. & Wilson, *in* J.D.Hooker, *Fl. Nov.-Zel.* 2: 119 (‘1855’) [1854]; *Hypopterygium pallens* (Hook.f. & Wilson) Mitt., *Hooker’s J. Bot. Kew. Gard. Misc.* 8: 265 (1856); *Hypopterygium pallens* (Hook.f. & Wilson) Reichardt, *Reise Novara, Pilze, Leber-Laubm.* 1(3): 194 (1870), *nom. illeg.* (later homonym). T: Hutt Valley, Wellington, North Island, New Zealand, *D.Lyall 126*; lecto: BM, *fide* J.D.Kruijer, *Blumea*, Suppl. 13: 255 (2002); Waikehi, New Zealand, *J.Sinclair s.n.*; syn: BM; Ship Cove, New Zealand, *D.Lyall s.n.*; syn: BM; Bay of Islands, North Island, New Zealand, *J.D.Hooker 386* (“New Zealand, Antarct. Exp. 1839–43”); syn: BM; Auckland, North Island, New Zealand, *J.Sinclair s.n.*; syn: BM; Wellington, North Island, New Zealand, *D.Lyall 112*; syn: BM; Milford Sound, South Island, New Zealand, *D.Lyall 23*; syn: BM; Bligh’s Sound, South Island, New Zealand, *D.Lyall 184*; syn: BM.

Hypopterygium hyalinolimbatum Müll.Hal. ex Kindb., *Hedwigia* 40: 281 (1901), *nom. nud.* (in synon.) [*H. pallens* (Hook.f. & Wilson) Mitt. subsp. *plumarium* (Mitt.) Kindb.]; *Lopidium hyalinolimbatum* M.Fleisch., *Hedwigia* 63: 213 (1922), *nom. nud.*; *H. hyalolimbata* Müll.Hal. ex Burges, *Proc. Linn. Soc. New South Wales* 60: 88 (1935), *nom. illeg.*, *orthogr. err. pro H. hyalinolimbatum* Müll.Hal. ex Kindb. Based on: Moss Vale, N.S.W., 8 Nov. 1884, *T.Whitelegge s.n.* [MEL (sub no. *189*, “on rocks”), S].

Illustrations: B. & N.Malcolm, *Mosses and other Bryophytes* 1, 78, 86, 156 (2000); J.D.Kruijer, *Blumea*, Suppl. 13: 50, pl. 3b; 257, fig. 37; 258, fig. 38; 270, fig. 41B (2002); W.R.Buck, D.H.Vitt & W.M.Malcolm, *Key to the Genera of Australian Mosses* 37 (2002).

Monoicous (or dioicous), unisexual (in Australia). Plants not gemmiferous. Stipe to 2.0 (–2.5) cm long. Frond to 5 (–9) cm long; central strand absent; axial cavities absent, cortical or central, 5–9 (T.S.); terminal cell of axillary hairs suborbicular to rectangular, short to elongate, (10–) 15–35 × (7–) 10–15 µm, smooth. Frond leaves ovate to oblong or lanceolate-ovate, 0.5–3.5 mm long, (0.2–) 0.5–1.5 mm wide; distal ones occasionally caducous; margin weakly serrate-dentate to moderately serrate; teeth 1-celled, to 40 µm long; border entire or interrupted near the leaf apex, colourless; laminal cells 7–20 × 7–20 µm. Paraphyses of mature perichaetia absent or filiform or leaf-like, to 1.3 mm long, to 0.2 mm wide, shorter than the perichaetial leaves. Calyptra 1.2–2.5 mm long, glabrous. Setae 3.5–6.0 mm long. Capsules subglobose to cylindrical, 0.7–2.0 mm long, 0.4–1.0 mm wide; operculum 0.9–1.4 mm long. OPL: PPL: IPL = 4: 2: 4–6c. Exostome teeth 390–600 µm long, 75–90 µm wide. Basal membrane reaching one-third of the exostome. Spores 11–20 µm. *n* = 12, *fide* H.P.Ramsay, *in* A.Löve, *Taxon* 16: 559 (1967); H.P.Ramsay, *Austral. J. Bot.* 22: 327, 328 (1974); G.A.M.Scott & I.G.Stone, *The Mosses of Southern Australia* 401 (1976), based on material from N.S.W. Plate 64.

Occurs in N.S.W., Vic. (to 1130 m altitude) and Tas. (to 500 m), and possibly in southern Qld; restricted to the east and south of the Great Dividing Range. Grows on trunks, stem bases and the branches of trees; also on tree ferns and on rocks; less frequently terrestrial or on exposed roots, in forests, often in shaded or wet habitats. Also in New Zealand, Chile, Bolivia and Brazil, and doubtfully in Norfolk Is. (Kruijer, 2002). Map 237.

N.S.W.: Nadgee State Forest, *H.Streimann 38183* (CANB, NY). Vic.: Turtons Rd, Otway Ra., *H.Streimann 2453* (CANB, L). Tas.: Hellyer Gorge, *W.A.Weber & D.McVean B-33365* (GRO, NICH, NY).

One specimen was possibly collected in southern Qld [Moreton Bay (MEL)], but its collector is unknown and mislabelling cannot be ruled out.

Plants show great variability in the length and density of the leaves and amphigastria. Deeply shaded plants often have distant leaves and amphigastria, and are frequently weakly branched with a few, short and distant branches. Fruiting specimens were frequently found.

According to Kruijer (2002) most plants belong to an informal “anisophyllous” variant of *L. concinnum* which is characterised by having an anisophyllous foliation and asymmetrical, ovate to ovate-oblong lateral leaves. Other plants belong to an “isophyllous” variant with partly or entirely isophyllous foliation with symmetrical, ovate to lanceolate-ovate lateral leaves. Isophyllous plants are often dioicous, predominantly male, and frequently have caducous frond leaves. Plants that belong to the anisophyllous variant are less often dioicous and have less frequently caducous leaves. The two variants are not sharply defined, and intermediates are known.

2. Lopidium struthiopteris (Brid.) M.Fleisch., *Musc. Buitenzorg* 3: 1073 (1908)

Hypnum struthiopteris Brid., *Muscol. Recent.*, Suppl. 2: 87 (1812); *Pterygophyllum struthiopteris* (Brid.) Brid., *Muscol. Recent.*, Suppl. 4: 151 (‘1819’) [1818]; *Hookeria struthiopteris* (Brid.) Arn., *Disp. Méth. Mousses* (preprint) 56 (1825 [1826?]); *Mém. Soc. Hist. Nat. Paris*, sér. 2, 2: 305 (1826); *Hypopterygium struthiopteris* (Brid.) Brid., *Bryol. Univ.* 2: 716 (1827). T: In Insula Borboniâ hâbitat [Réunion], *P.Commerson*(?) *s.n.*; holo: B (destroyed); iso: not located with certainty; Réunion, *P.Commerson s.n.*; neo: BM, *fide* J.D.Kruijer, *Blumea*, Suppl. 13: 265 (2002).

Lopidium pinnatum Hampe, *Linnaea* 38: 672 (1874); *Hypopterygium pinnatum* (Hampe) A.Jaeger, *Ber. Tätigk. St. Gallischen Naturwiss. Ges.* 1874–75: 150 (*Gen. Sp. Musc.* 2: 66) (1876); *Hypopterygium struthiopteris* (Brid.) Brid. subsp. *pinnatum* (Hampe) Kindb., *Hedwigia* 40: 282 (1901); ?*Hypopterygium planatum* Müll.Hal. ex Mitt., *in* F.Mueller, *Fragm.* 11 (Suppl.): 114 (1881), *nom. inval.*, *err. pro H. pinnatum* (Hampe) A.Jaeger?; *Hypopterygium planatum* Hampe ex Mitt., *Trans. & Proc. Roy. Soc. Victoria* 19: 76 (1882), *nom. inval.*, *err. pro H. pinnatum* (Hampe) A.Jaeger; *Lopidium planatum* Hampe ex Mitt. ex Streimann & Klazenga, *Cat. Austral. Mosses* 112 (2002), *nom. inval.*, *err. pro H. planatum* Hampe ex Mitt. T: Mt Elliot, Qld, *K.Fitzalan s.n.*; holo: BM; iso?: MEL (“parce intermixitum”), S (sub no. 8).

Hypopterygium daymanianum Broth. & Geh., *in* V.Brotherus, *Oefvers. Förh. Finska Vetensk.-Soc.* 40: 193 (1898); *Hypopterygium struthiopteris* (Brid.) Brid. subsp. *daymanianum* (Broth. & Geh.) Kindb., *Hedwigia* 40: 283 (1901); *Lopidium daymanianum* (Broth. & Geh.) M.Fleisch., *Musc. Buitenzorg* 3: 1071 (1908). T: Mt Dayman, Milne Bay Prov., [Papua] New Guinea, 1894?, *W.E.Armit Jnr s.n.*; holo: H *n.v.*; iso: FH (ex Herb. Geheeb), S (sub 658, ex Herb. Brotherus).

Illustrations: H.Mohamed & H.Robinson, *Smithsonian Contr. Bot.* 80: 41, figs 151–158; 42, figs 159–168 (1991); M.L.So, *Mosses & Liverworts of Hong Kong* 61 (1995); J.D.Kruijer, *Blumea*, Suppl. 13: 50, pl. 3a; 269, figs 39, 40; 270, fig. 41A (2002).

Dioicous. Plants frequently gemmiferous. Stipe to 3 cm long. Frond to 6 cm wide; central strand present or absent; axial cavities absent, (sub)central, 1 or 2 (T.S.); terminal cell of axillary hairs suborbicular to narrowly elliptic, short, 10–20 × 7–15 µm wide. Frond leaves ovate to lanceolate-ovate, (0.3–) 1.0–2.5 mm long, (0.1–) 0.4–1.0 mm wide, not caducous; margin entire or weakly serrate to moderately serrate-dentate; teeth 1 or 2-celled, to 18 µm long; border absent, interrupted or entire; laminal cells 5–20 (–25) × 5–15 µm. Paraphyses of mature perichaetia leaf-like, to 2.5 mm long, 0.05 mm wide, at least a few longer than the perichaetial leaves. Calyptra 2.1–2.5 mm long, set with paraphyses. Setae 4–10 mm long. Capsules barrel-shaped to cylindrical, 1.9–3.1 mm long, 0.6–1.0 mm wide; operculum 1.2–2.0 mm long. OPL: PPL: IPL = 4: 2: (4?–)6–8c. Exostome teeth 300–345 µm long, 50–60 µm wide. Basal membrane reaching c. 10% the height of the exostome. Spores 13–19 µm. n = 11, *fide* S.Inoue, *Misc. Bryol. Lichenol.* 8: 112 (1979), based on Japanese material.

Occurs in eastern Qld and north-eastern N.S.W.; grows on tree trunks, also on treelets, branches and climbers, occasionally on tree ferns, rock (granite, limestone, conglomerate and sandstone) and rotting logs, rarely on soil; found in forest, usually in deep or partial shade, but occasionally in open habitats. Also in Africa, Indo-Malaysia, warm-temperate parts of China and Japan and Melanesia. Map 238.

Qld: Mt Finnegan, *L.J.Brass 20093* (FH); Walter Hill Ra., *H.Streimann 30553* (CANB, L, NY); Lamington Natl Park, *B.M.Thiers 1205* (NY). N.S.W.: Briggsvale, *H.Streimann 6633* (CANB).

Lopidium struthiopteris was reported from Tasmania by W.Mitten (*J. Proc. Linn. Soc., Bot.* 4: 96, 1860) and from New Zealand, Tasmania and Chile by J.D.Hooker (*Handb. New Zealand Fl.* 489, 1867), because they erroneously considered this species to be conspecific with *L. pallens* Hook.f. & Wilson.

The dimensions of the frond leaves, the shape of the leaf apex and the extent of the leaf border show great variability. The border of branch leaves is frequently less well developed than that in rachis leaves. The absence of a leaf border or the presence of a faint or interrupted border occurs most frequently in small plants or small stems of medium-sized or large plants. A border is frequently absent in the leaves of minute plants. Small plants occur at every altitude, but large plants are possibly restricted to higher elevations.

A variant found most commonly in Qld is represented by ±slender plants that have only a few distant branches. The branches and lateral frond leaves are usually erecto-patent.

The ‘normal’ variant of *L. struthiopteris* predominates in most other parts of the distributional area of the species, but it also occurs in Qld. Plants are moderately to densely branched and have several to numerous, closely set branches. The branches are patent to widely patent. The lateral frond leaves similarly often patent to widely patent, and are less frequently erecto-patent than in the ‘Queensland’ variant. The two variants are not sharply defined and intermediates are known (Kruijer, 2002).

Doubtful Species

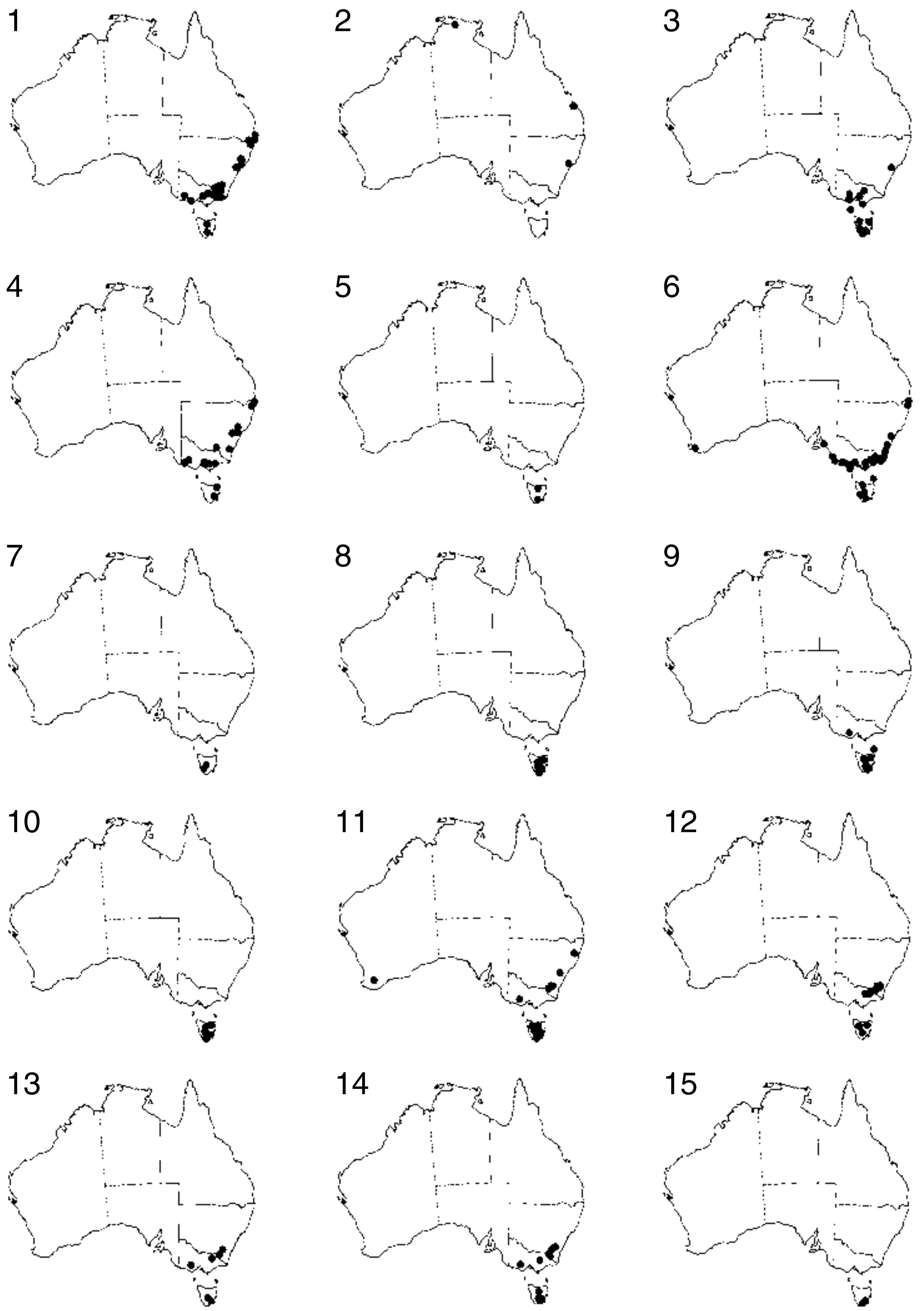
Lopidium nematosum (Müll.Hal.) M.Fleisch., *Hedwigia* 63: 213 (1922)

Hypopterygium nematosum Müll.Hal., *J. Mus. Godeffroy* 3: 80 (1874); *H. struthiopteris* (Brid.) Brid. subsp. *nematosum* (Müll.Hal.) Kindb., *Hedwigia* 40: 282 (1901). T: N.S.W., *Mrs Kayser s.n.*; holo: B (destroyed); iso: not located.

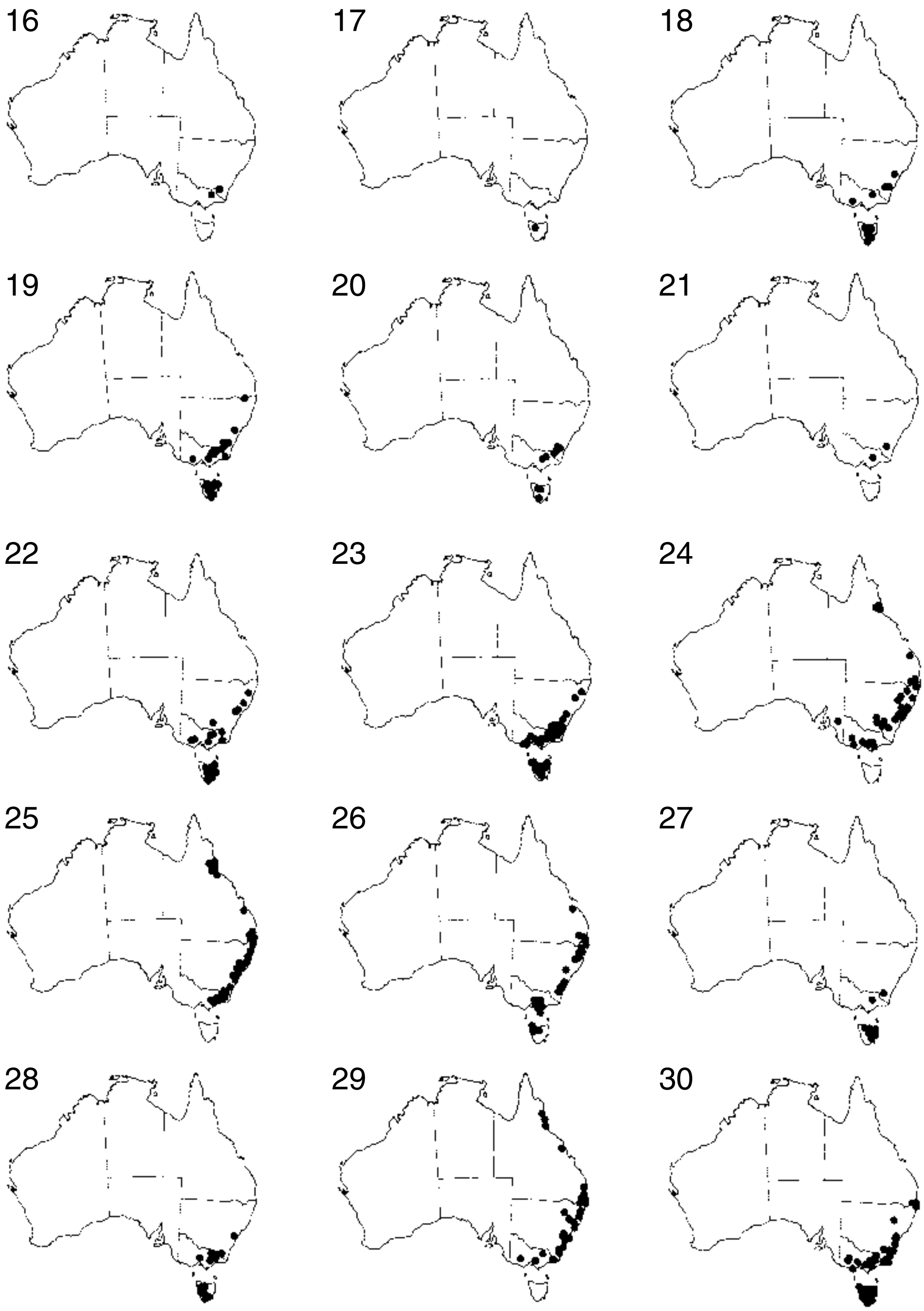
This is probably conspecific with one of the two accepted *Lopidium* species (Kruijer, 2002).

MAPS

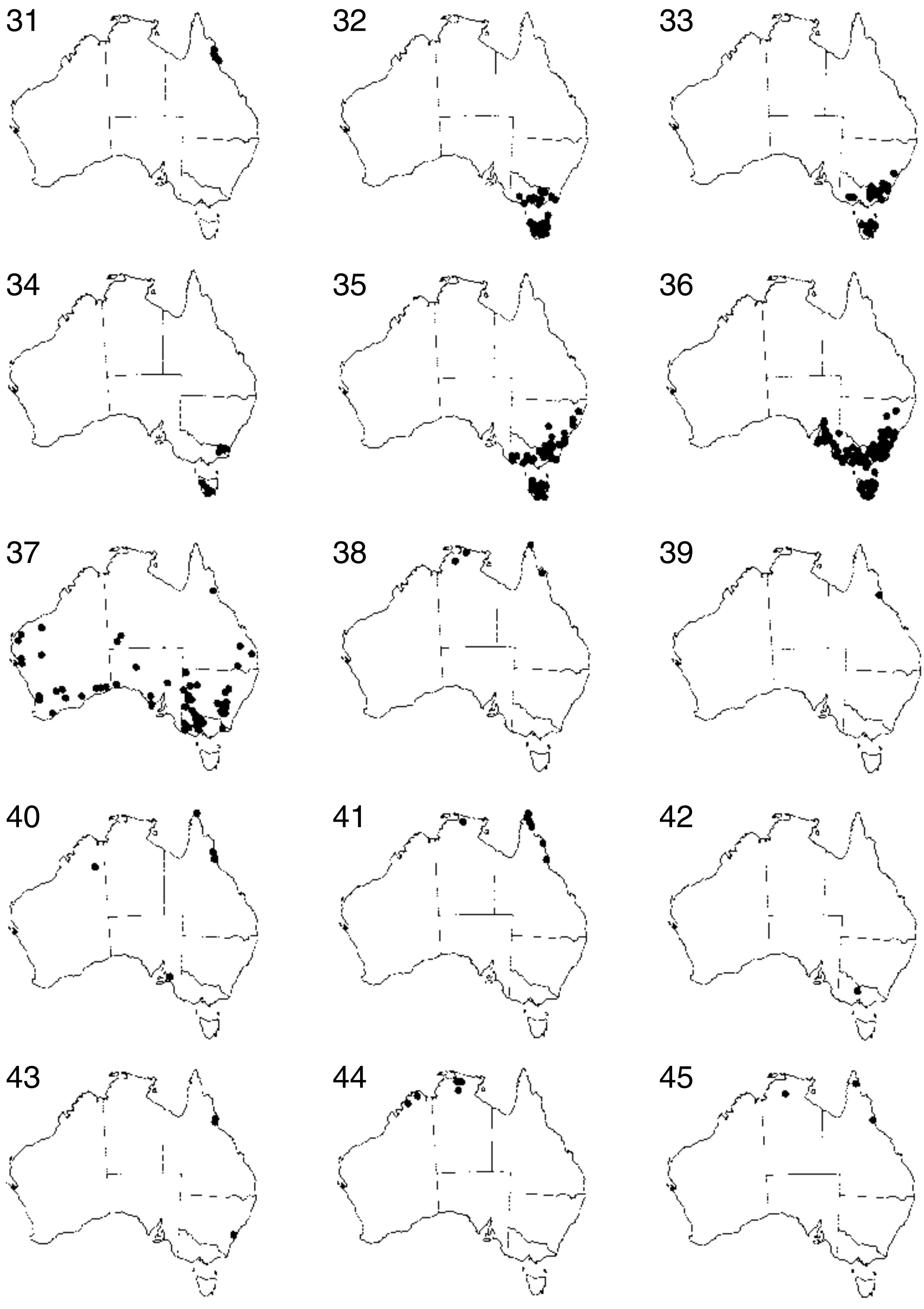
Number in brackets refers to the page on which the taxon is described.



1. Sphagnum cristatum (91)
2. Sphagnum perichaetiale (92)
3. Sphagnum australe (96)
4. Sphagnum falcatulum (97)
5. Sphagnum fuscovinosum (100)
6. Sphagnum novozelandicum (100)
7. Ambuchanania leucobryoides (105)
8. Andreaea acuminata (110)
9. Andreaea acutifolia (111)
10. Andreaea alpina (114)
11. Andreaea amblyophylla (114)
12. Andreaea australis (115)
13. Andreaea flabellata (115)
14. Andreaea flexuosa (116)
15. Andreaea gainii (116)



16. Andreaea heinemannii (117)
17. Andreaea huttonii (118)
18. Andreaea microvaginata (118)
19. Andreaea mutabilis (121)
20. Andreaea nitida (121)
21. Andreaea subulata (122)
22. Andreaea sp. (123)
23. Atrichum androgynum (126)
24. Dawsonia longiseta (129)
25. Dawsonia polytrichoides (130)
26. Dawsonia superba var. pulchra (131)
27. Notoligotrichum australe (132)
28. Notoligotrichum crispulum
29. Pogonatum neesii (134)
30. Pogonatum subulatum (134)



31. Pogonatum tubulosum (136)
32. Polytrichadelphus magellanicus (137)
33. Polytrichastrum alpinum (138)
34. Polytrichastrum formosum (138)
35. Polytrichum commune (140)
36. Polytrichum juniperinum (142)
37. Gigaspermum repens (145)
38. Archidium birmanicum (148)
39. Archidium brevinerve (149)
40. A. capense (149)
41. A. clarksonianum (150)
42. A. clavatum (150)
43. A. elatum (151)
44. A. indicum (151)
45. A. microthecium (152)

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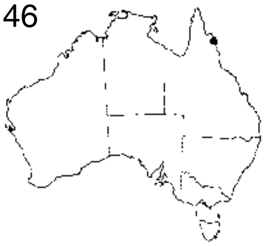

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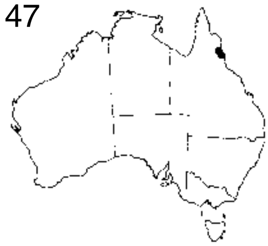

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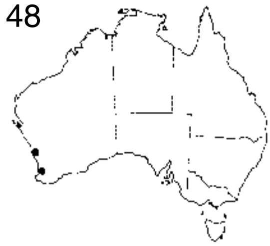

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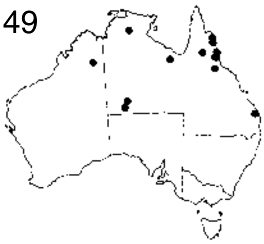

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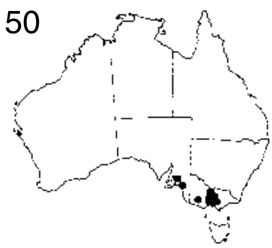

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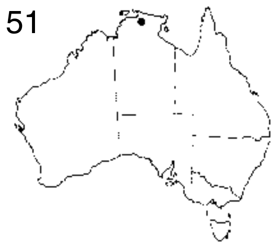

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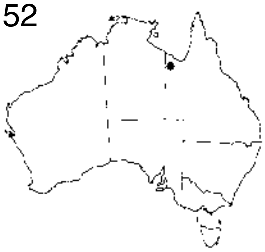

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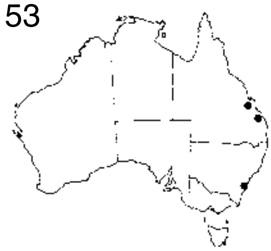

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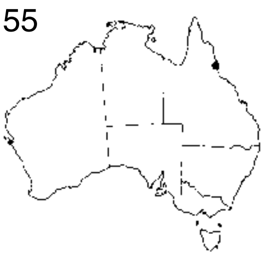

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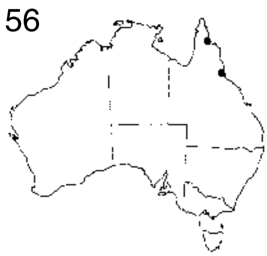

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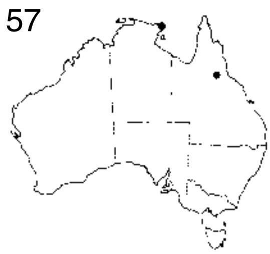

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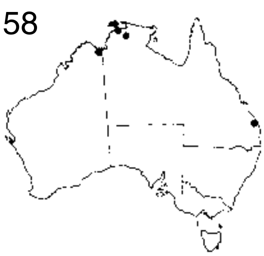

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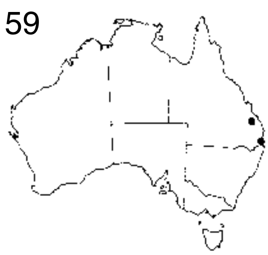

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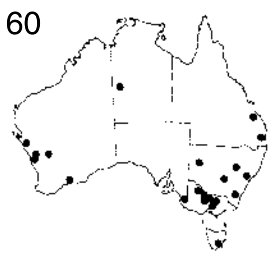
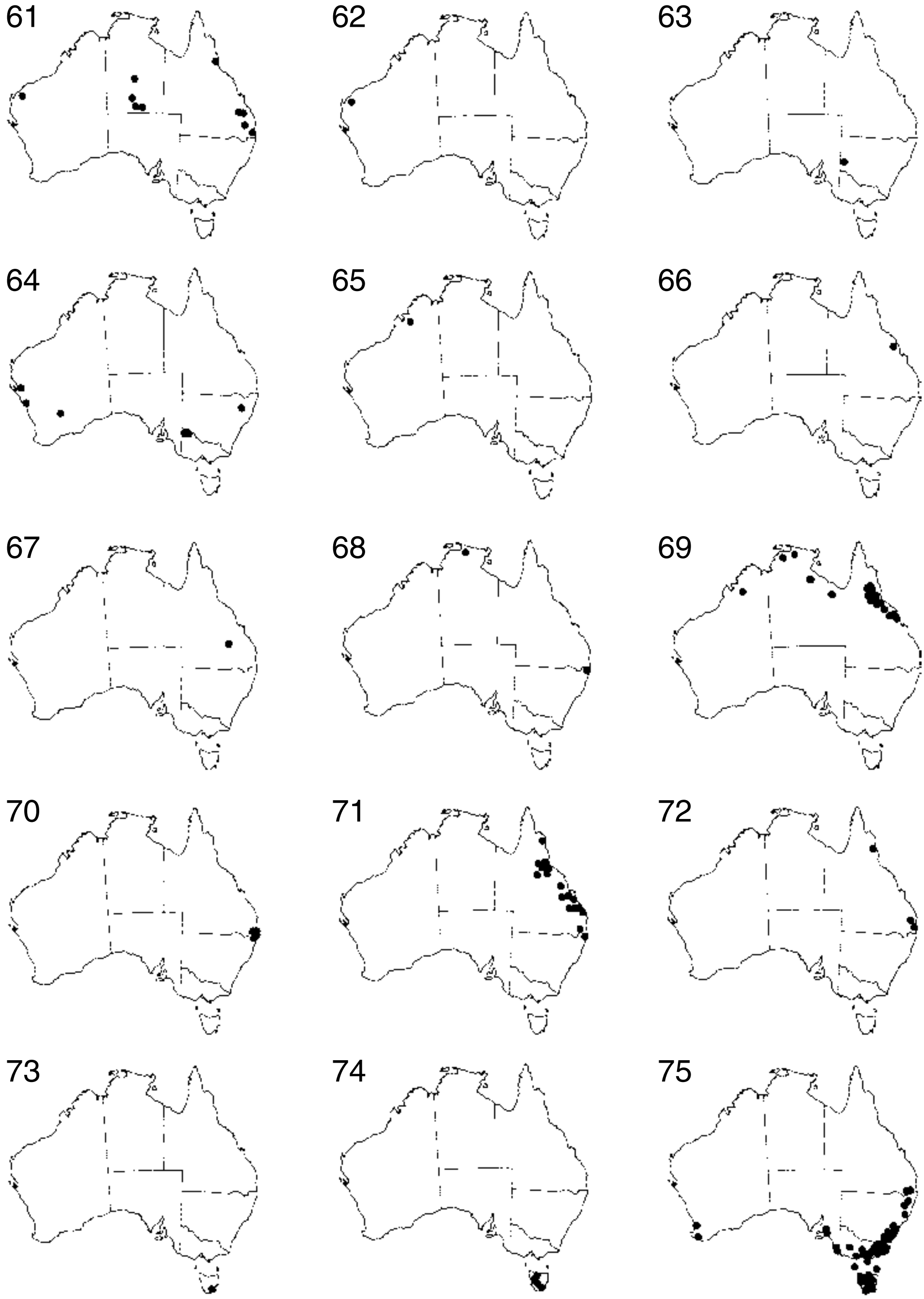


46. Archidium minutissimum (152) **47.** Archidium ohioense (153) **48.** Archidium rehmannii (153)
49. Archidium rothii (153) **50.** Archidium stellatum (154) **51.** Archidium subulatum (154)
52. Archidium thalliferum (155) **53.** Archidium wattsii (155) **54.** Archidium sp. A (156)
55. Archidium sp. B (156) **56.** Archidium sp. C (157) **57.** Gymnostomiella vernicosa var. vernicosa (161)
58. Splachnobryum obtusum (161) **59.** Ephemerum capense (164) **60.** Ephemerum cristatum (164)



61. Ephemerum fimbriatum (165) **62.** E. furcatum (165) **63.** E. recurvifolium (165)
64. E. rehmannii (166) **65.** Nanomitriopsis longifolia (167) **66.** Erpodium beccarii var. beccarii (169)
67. E. beccarii var. longicalyptratum (169) **68.** E. biseriatum (170) **69.** E. coronatum var. australiense (170)
70. E. glaucum var. glaucum (171) **71.** E. hodgkinsoniae (171) **72.** E. solmsiellaceum (172)
73. Tayloria callophylla (174) **74.** Tayloria gunnii (175) **75.** Tayloria octoblepharum (178)

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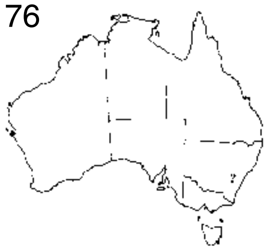
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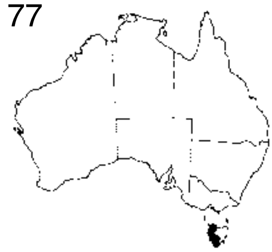
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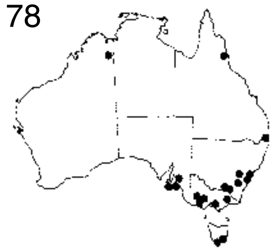
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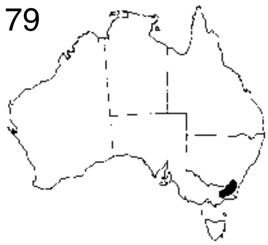
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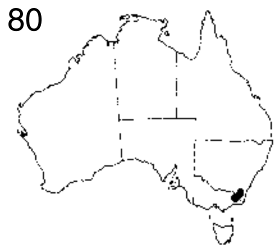
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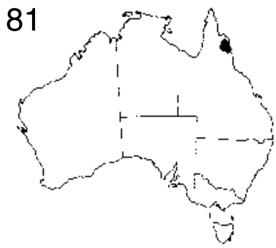
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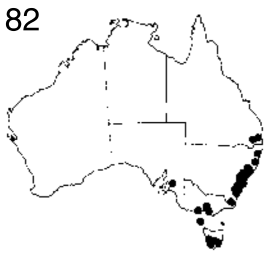
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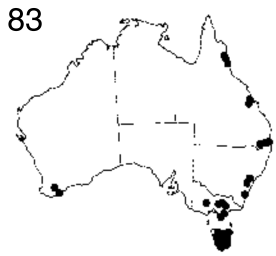
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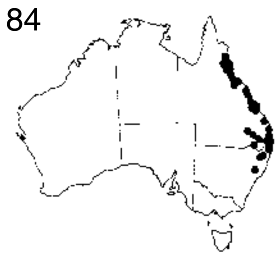
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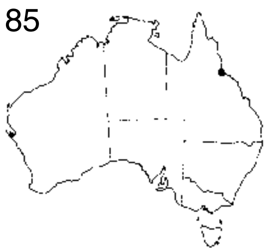
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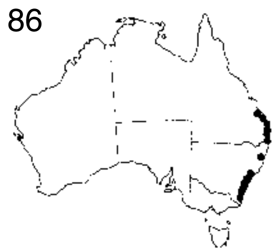
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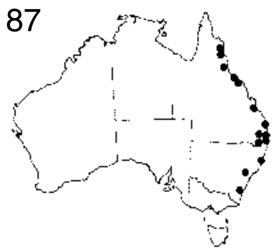
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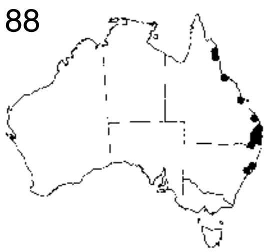
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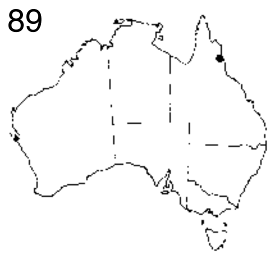
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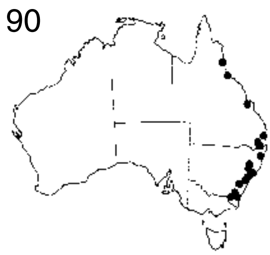
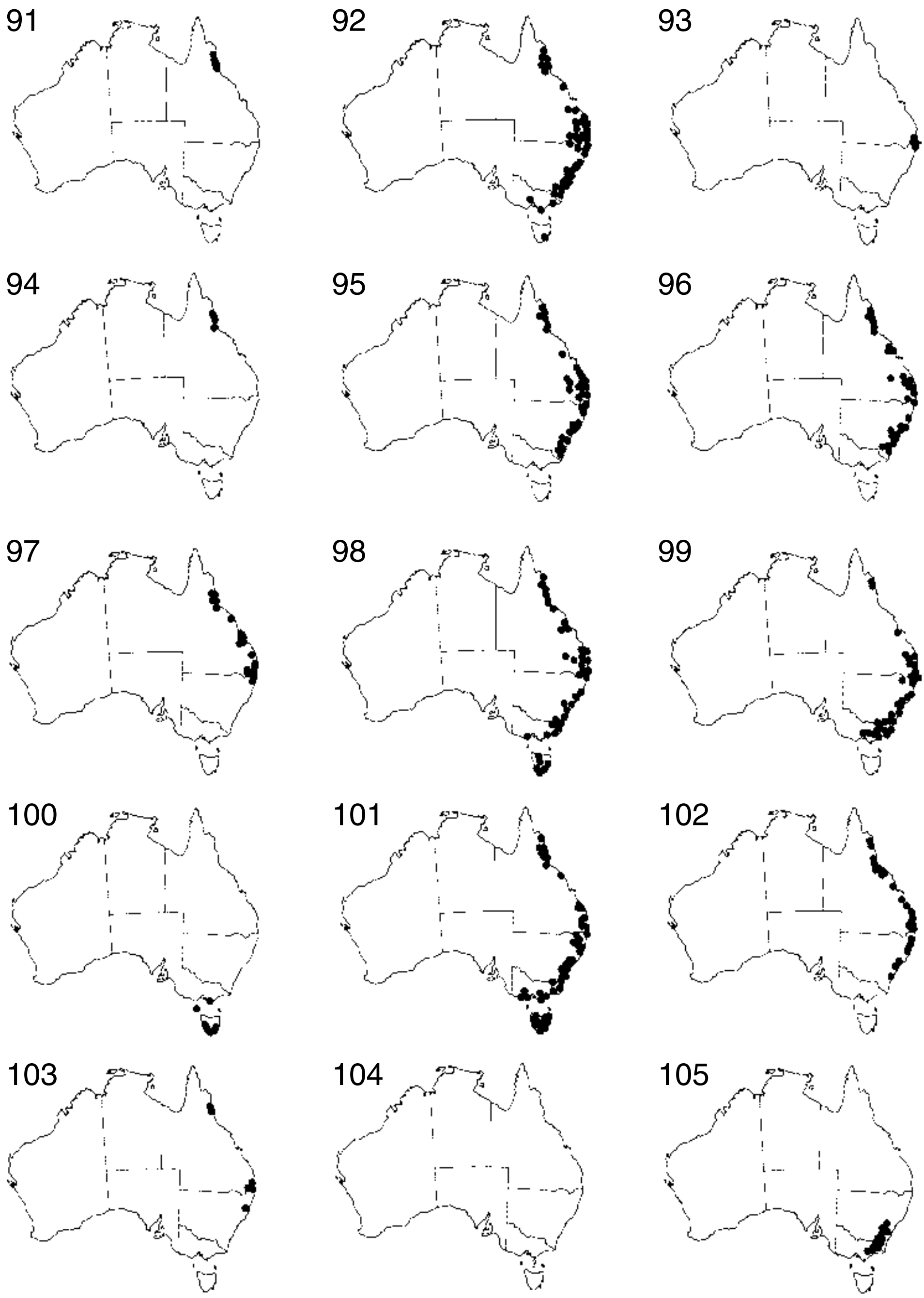


76. Tayloria purpurascens (179)
77. Tayloria tasmanica (180)
78. Leptobryum pyriforme (184)
79. Meesia muelleri (185)
80. Meesia triquetra (186)
81. Groutiella tomentosa (189)
82. Macrocoma tenuis subsp. tenuis (191)
83. Macromitrium archeri (195)
84. M. aurescens (196)
85. M. brachypodium (198)
86. M. brevicaule (200)
87. M. caloblastoides (201)
88. M. diaphanum (201)
89. M. dielsii (202)
90. M. exsertum (204)



91. Macromitrium funiforme (205)
92. M. hemitrichodes (205)
93. M. hortoniae (206)
94. M. incurvifolium (207)
95. M. involutifolium subsp. involutifolium (208)
96. M. involutifolium subsp. ptychomitrioides (210)
97. M. leratii (210)
98. M. ligulaefolium (211)
99. M. ligulare (212)
100. M. longirostre (213)
101. M. microstomum (213)
102. M. repandum (214)
103. M. stoneae (216)
104. M. subulatum (217)
105. Orthotrichum assimile (220)

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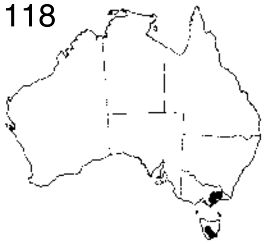

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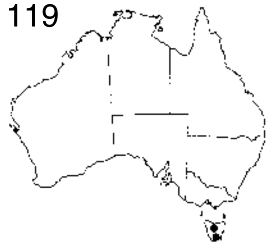

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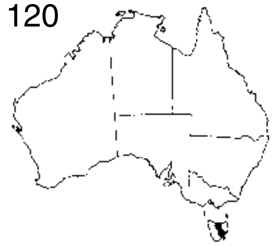
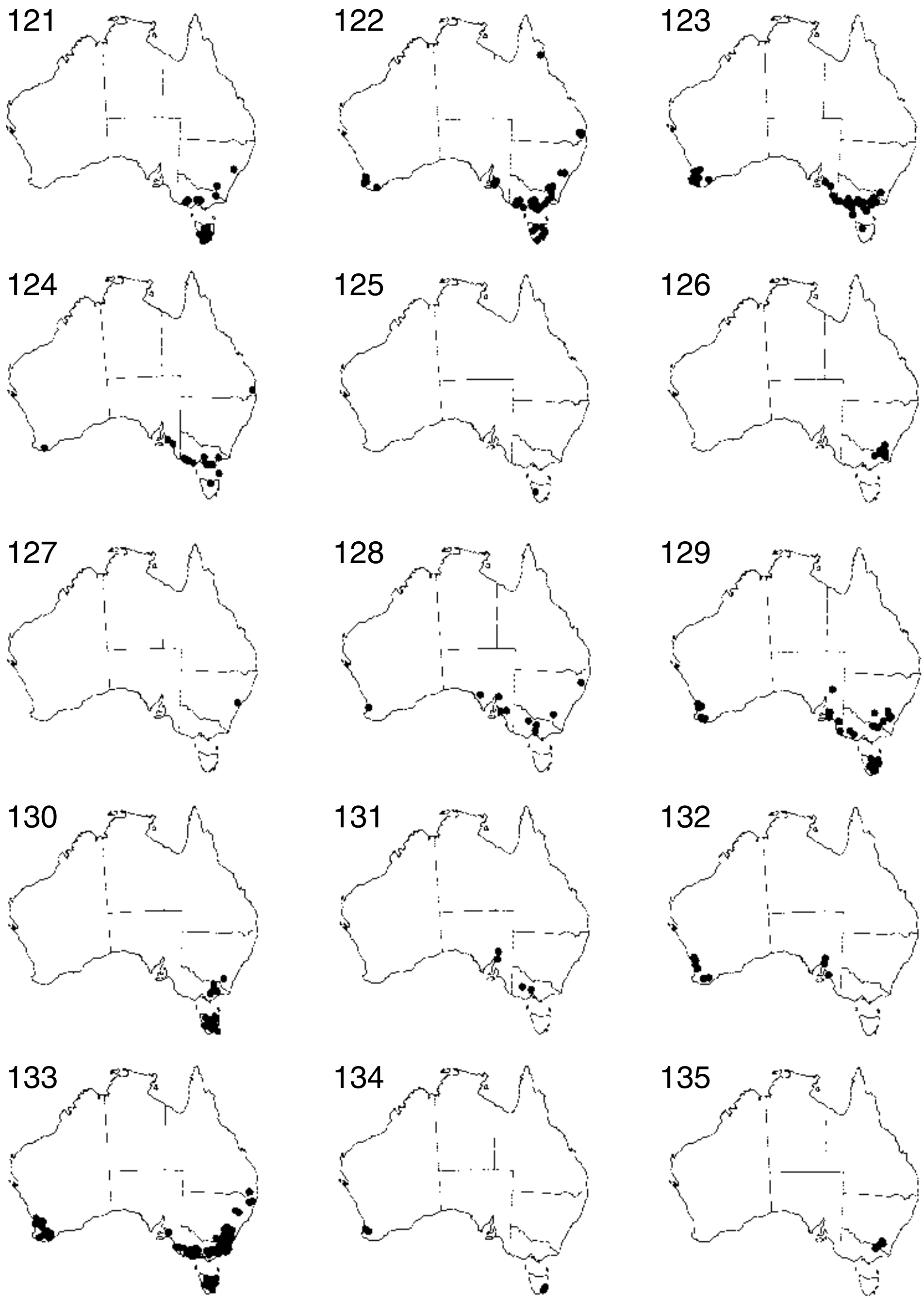
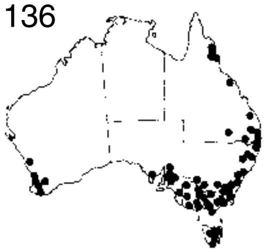


106. Orthotrichum cupulatum var. cupulatum (220)
107. Orthotrichum hortense (221)
108. Orthotrichum rupestre var. rupestre (221)
109. Orthotrichum tasmanicum var. tasmanicum (224)
110. Schlotheimia brownii (225)
111. Schlotheimia funiformis (226)
112. Stoneobryum bunyaense (227)
113. Ulota cochleata (229)
114. U. laticiliata (230)
115. U. lutea var. lutea (233)
116. U. lutea var. robusta (233)
117. U. membranata (233)
118. U. viridis var. viridis (236)
119. U. viridis var. dixonii (236)
120. Zygodon gracillimus (238)



121. Zygodon hookeri (239)
122. Zygodon intermedius (239)
123. Zygodon menziesii (240)
124. Zygodon minutus (243)
125. Zygodon obtusifolius (244)
126. Aulacomnium palustre (245)
127. Bartramia alaris (250)
128. Bartramia breutelii (251)
129. Bartramia hampeana subsp. hampei (251)
130. Bartramia mossmaniana (252)
131. Bartramia nothostricta (253)
132. Bartramia pseudostricta (253)
133. Bartramia robusta (254)
134. Bartramia strictifolia (255)
135. Bartramia subsymmetrica (255)

136



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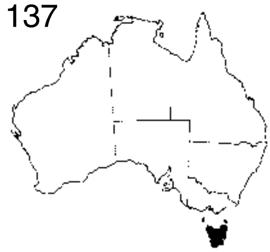

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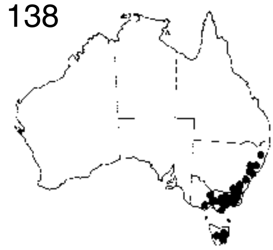

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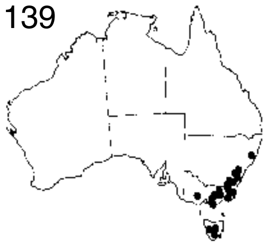

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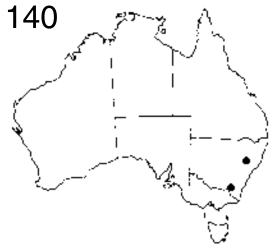

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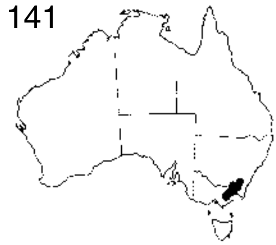

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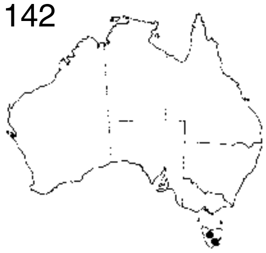

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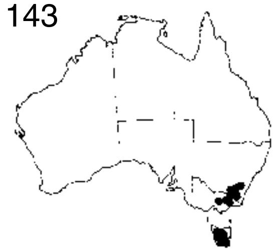

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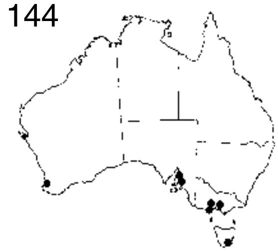

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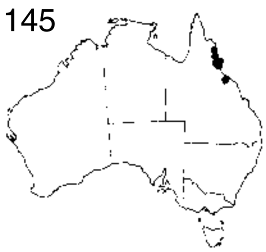

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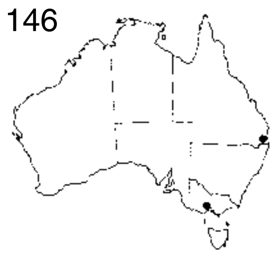

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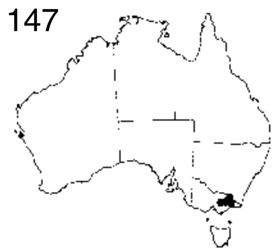

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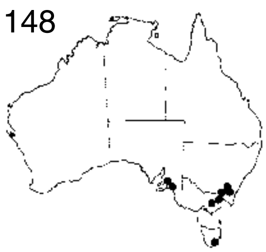

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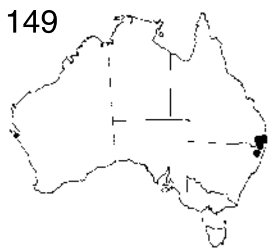

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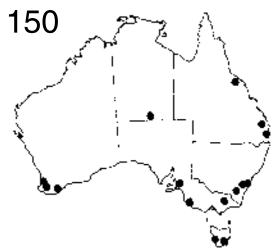
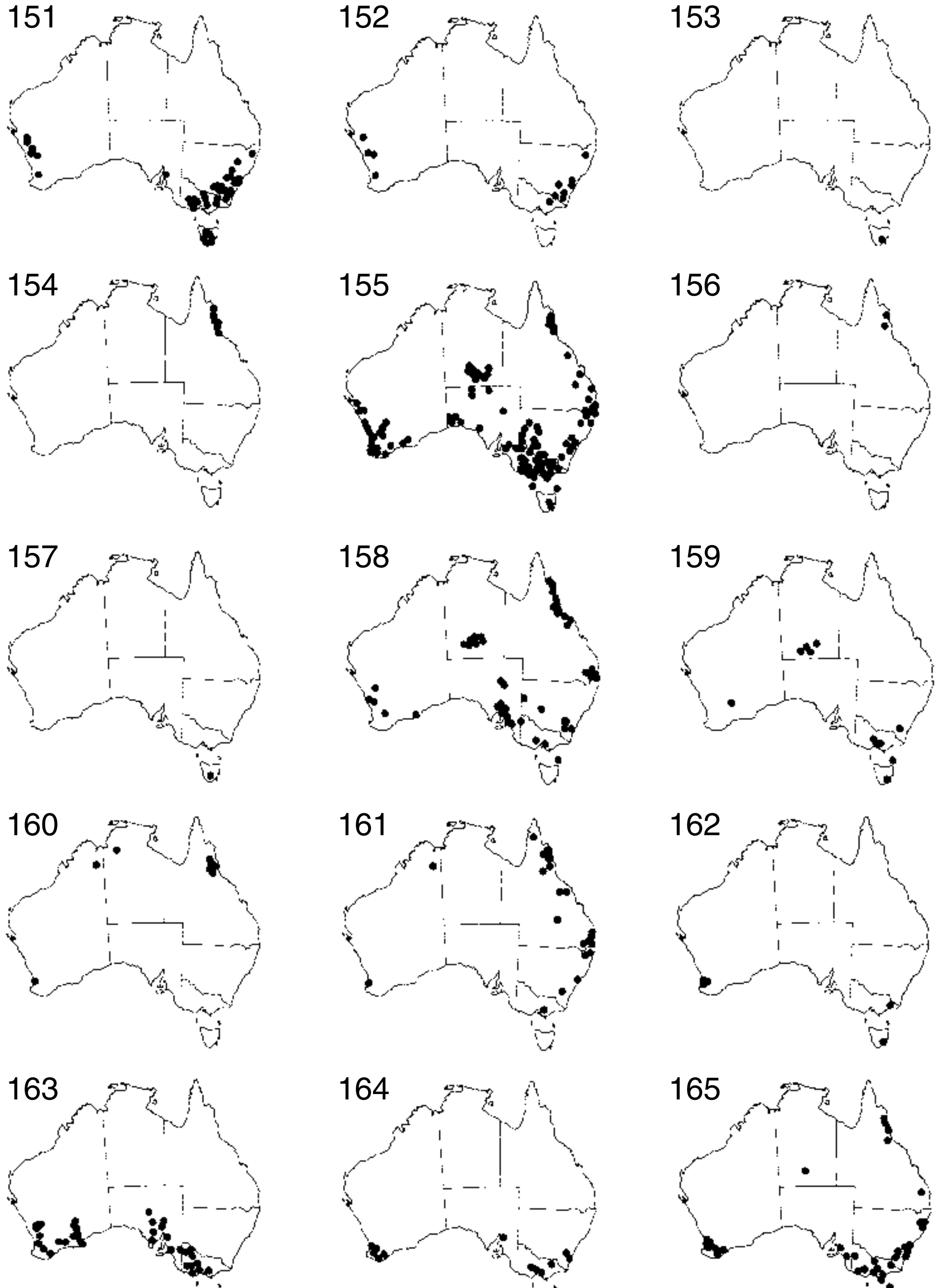
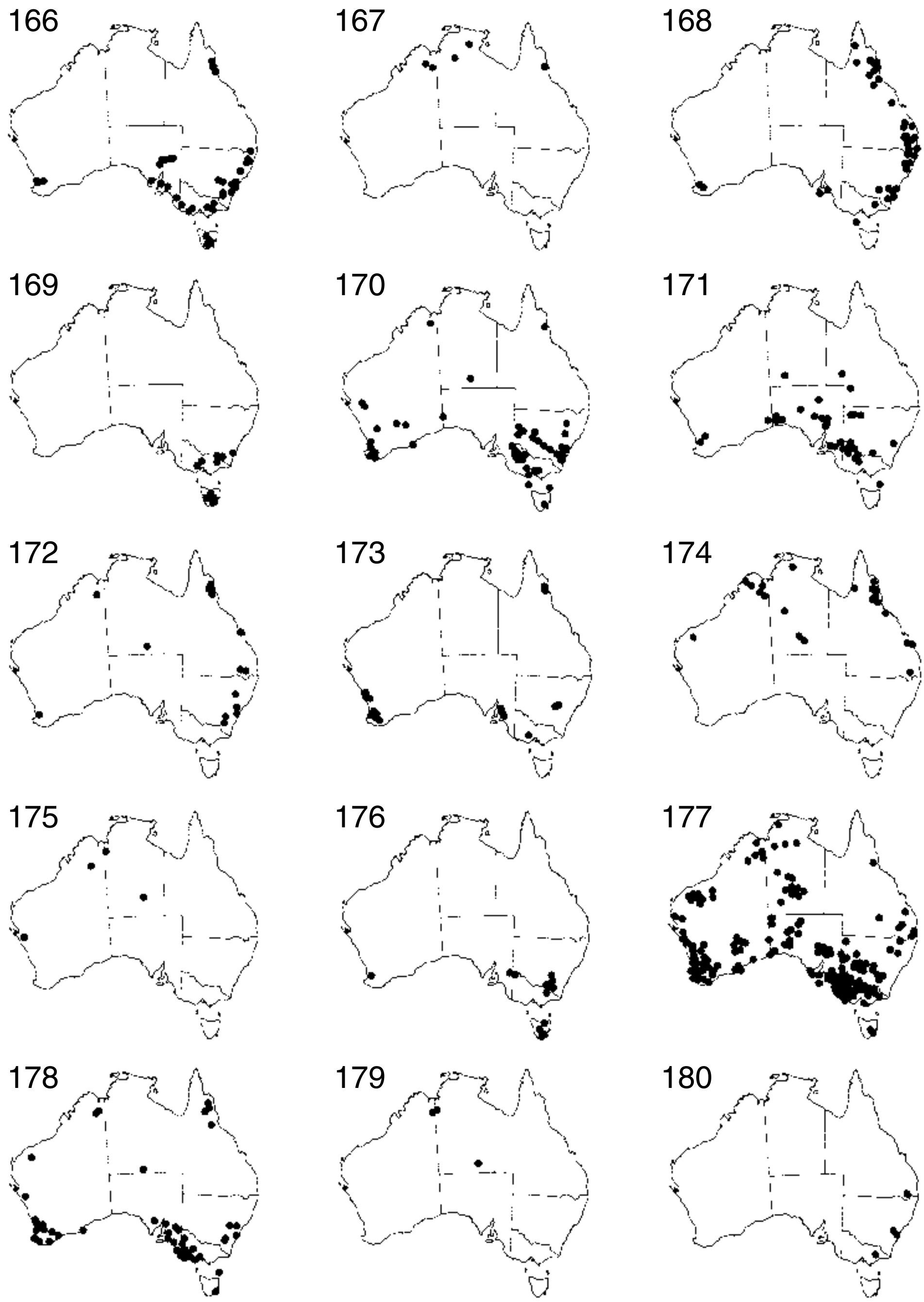


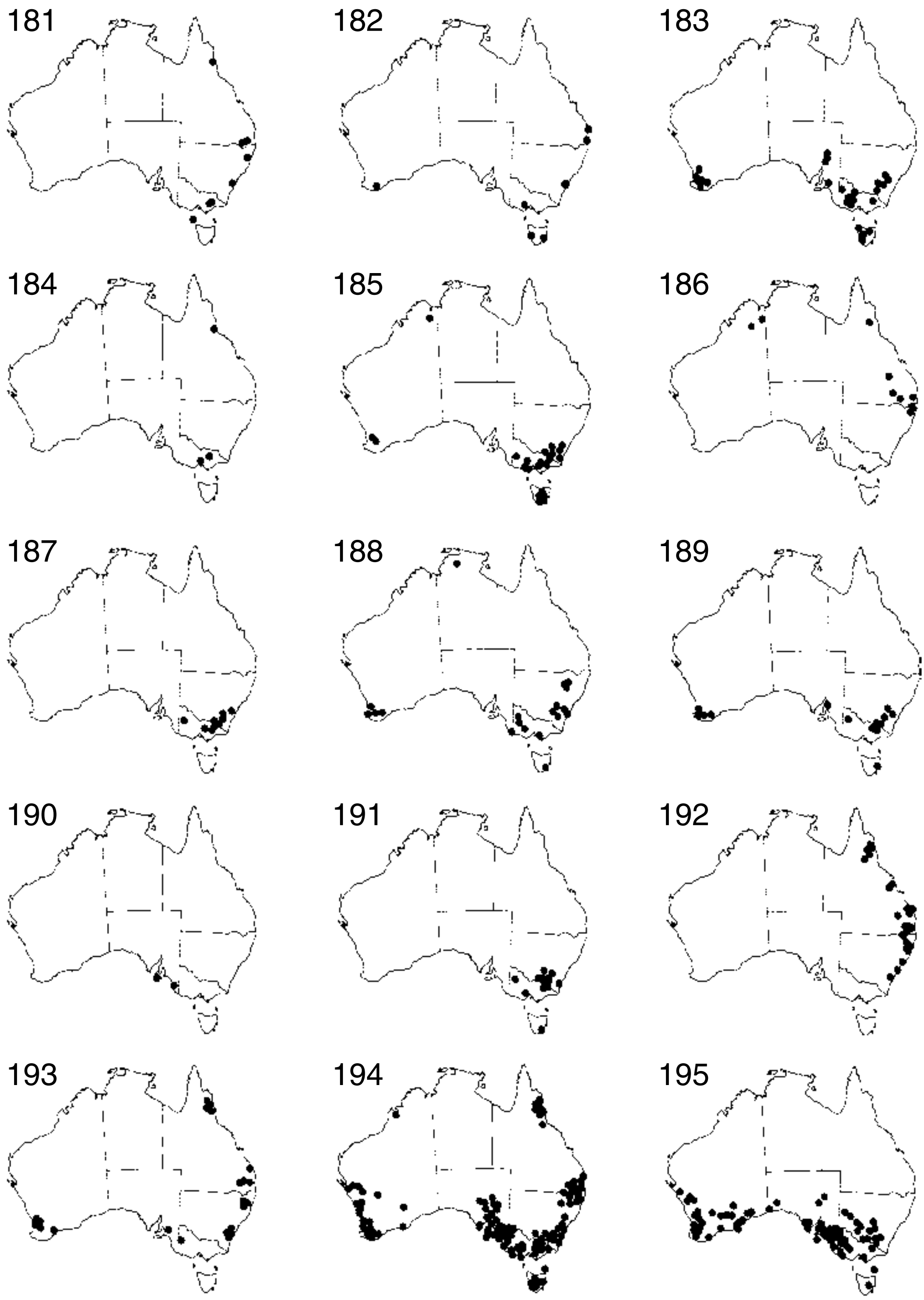
136. Breutelia affinis (257)
137. Breutelia elongata (257)
138. Breutelia pendula (259)
139. Breutelia pseudophilonotis (260)
140. Breutelia sp. A (260)
141. Conostomum curvirostre (263)
142. Conostomum pentastichum (264)
143. Conostomum pusillum var. pusillum (264)
144. Philonotis australiensis (266)
145. Philonotis hastata (266)
146. Philonotis pallida (267)
147. Philonotis pyriformis (267)
148. Philonotis scabrifolia (267)
149. Philonotis slateri (269)
150. Philonotis tenuis (269)



151. Orthodontium lineare (272)
152. Orthodontium pallens (273)
153. Brachymenium lanceolatum (278)
154. B. nepalense (278)
155. Bryum argenteum (282)
156. Bryum auratum (282)
157. B. harriottii (285)
158. B. lanatum (285)
159. B. subrotundifolium (286)
160. Gemmabryum acuminatum (290)
161. G. apiculatum (290)
162. G. australe (293)
163. G. austrosabulosum (294)
164. G. cheelii (296)
165. G. chrysoneuron (296)



166. Gemmabryum clavatum (297) **167.** G. coarctatum (298) **168.** G. coronatum (299)
169. G. crassum (300) **170.** G. dichotomum (300) **171.** G. eremaeum (301)
172. G. exile (302) **173.** G. inaequale (305) **174.** G. indicum (305)
175. G. klinggraeffii (306) **176.** G. laevigatum (306) **177.** G. pachythecum (307)
178. G. preissianum (308) **179.** G. radiculosum (309) **180.** G. rubens (309)



181. Gemmabryum sauteri (310) **182.** G. subapiculatum (310) **183.** G. sullivanii (319)
184. G. tenuisetum (320) **185.** Ochiobryum blandum (321) **186.** Plagiobryum cellulare (322)
187. Ptychostomum altisetum (324) **188.** P. angustifolium (326) **189.** P. creberrimum (326)
190. P. cylindrothecium (327) **191.** P. pseudotriquetrum (327) **192.** Rhodobryum aubertii (329)
193. Rosulabryum albolimbatum (333) **194.** Rosulabryum billarderi (333) **195.** Rosulabryum campylothecium (337)

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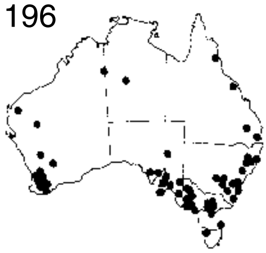
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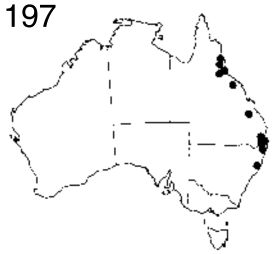
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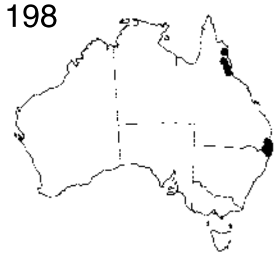
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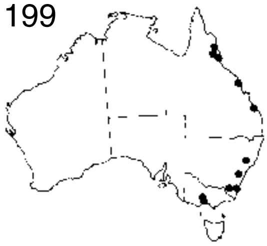
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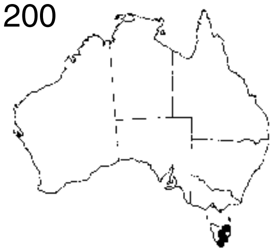
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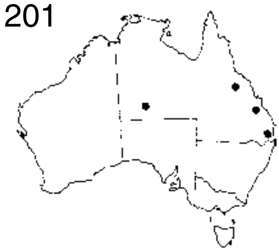
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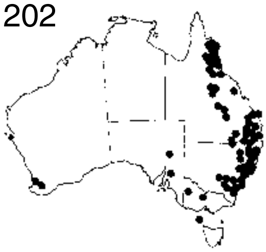
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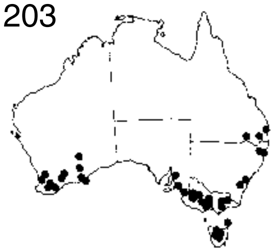
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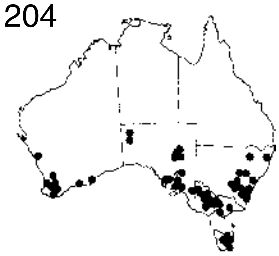
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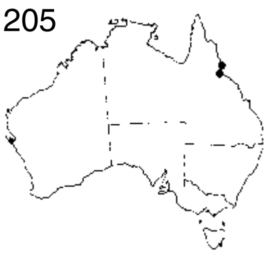
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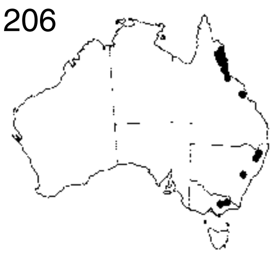
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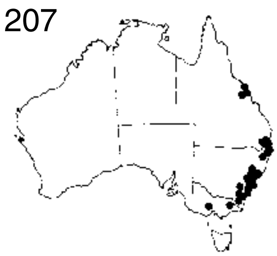
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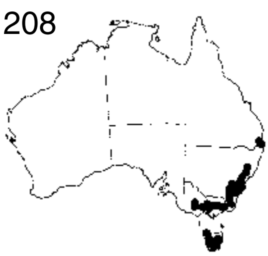
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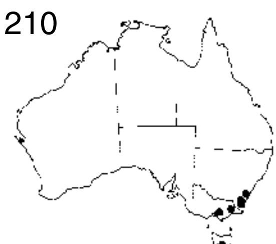
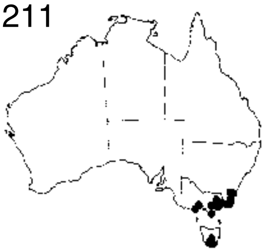


196. Rosulabryum capillare (338)
197. R. epiphyticum (339)
198. R. lamingtonicum (339)
199. R. leptothrix (340)
200. R. microrhodon (340)
201. R. queenslandicum (343)
202. R. subfasciculatum (343)
203. R. subtomentosum (344)
204. R. torquescens (345)
205. R. tuberosum (346)
206. R. wightii (346)
207. Leptostomum erectum (350)
208. Leptostomum inclinans (351)
209. Leptostomum macrocarpon (353)
210. Goniobryum subbasilare (355)

211



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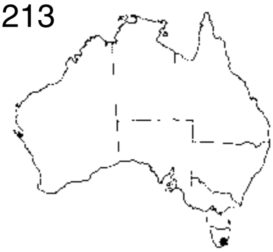

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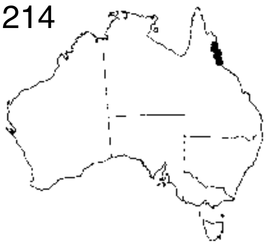

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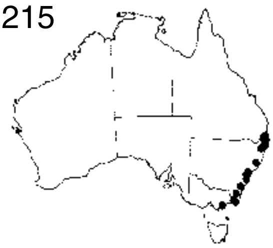

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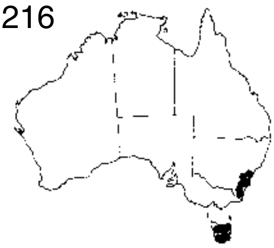

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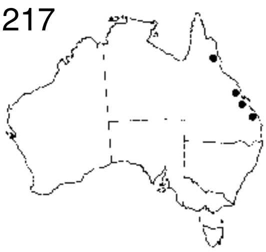

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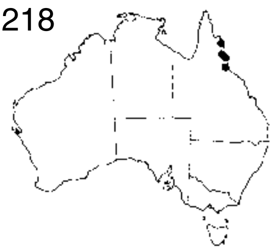

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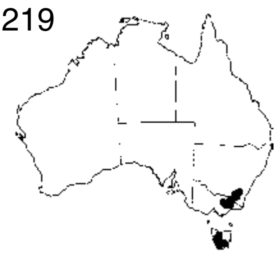

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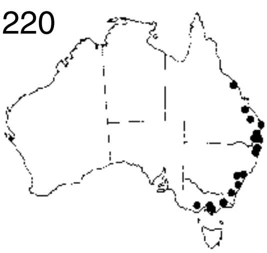

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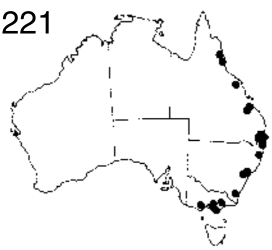

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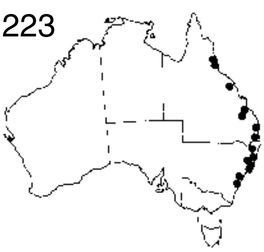

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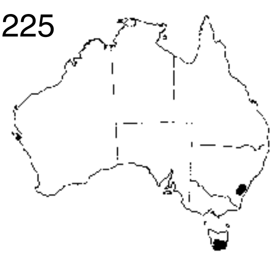


211. Hymenodon pilifer (356)

212. Leptotheca gaudichaudii var. gaudichaudii (357)

213. Leptotheca gaudichaudii var. wattsii (357)

214. Mesochaete taxiforme (358)

215. Mesochaete undulata (358)

216. Pyrrhobryum bifarium (360)

217. Pyrrhobryum latifolium (360)

218. Pyrrhobryum medium (362)

219. Pyrrhobryum mnioides (362)

220. Pyrrhobryum paramattense (363)

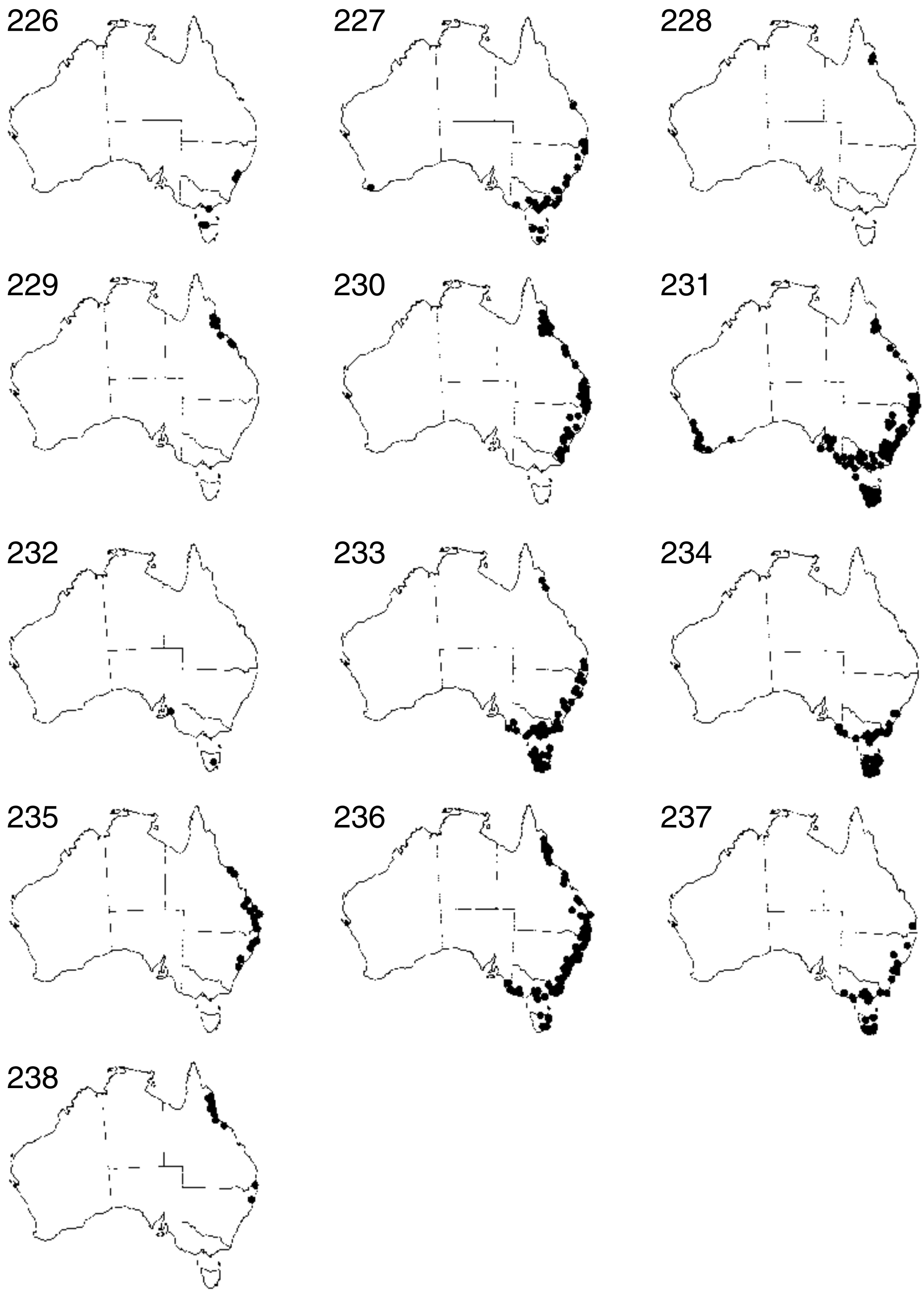
221. Pyrrhobryum spiniforme (363)

222. Rhizogonium distichum (364)

223. Rhizogonium graeffeanum (365)

224. Rhizogonium novaehollandiae (365)

225. Rhizogonium pennatum var. aristatum (366)



226. Calomnion complanatum (367)

227. Mittenia plumula (370)

228. Powellia integra (372)

229. Powellia involutifolia (373)

230. Racopilum cuspidigerum var. cuspidigerum (374)

231. Racopilum cuspidigerum var. convolutaceum (375)

232. Racopilum strumiferum (376)

233. Cyathophorum bulbosum (379)

234. Hypopterygium didictyon (382)

235. H. discolor (383)

236. H. tamarisci (383)

237. Lopidium concinnum (386)

238. Lopidium struthiopteris (387)

APPENDIX

New taxa, combinations and lectotypifications

New taxa, combinations and lectotypifications occurring in this volume of the *Flora of Australia* are formally published here. Taxa are arranged in the order they appear in the text. For economy the entries are brief; the treatment in the main text is more comprehensive. Accepted names are in **bold**, basionyms and synonyms in *italic*.

AMBUCHANANIALES

R.D.Seppelt[1] *& H.A.Crum*†

The order Ambuchananiales Seppelt & H.A.Crum (*in* H.A.Crum & R.D.Seppelt, *Contr. Univ. Michigan Herb.* 22: 29, 1999), the family Ambuchananiaceae Seppelt & H.A.Crum, and the genus *Ambuchanania* Seppelt & H.A.Crum were based on a single, composite description. If we assume that the Latin diagnosis referred to the new genus, and the new order did not require such a diagnosis, then the family name is invalid under Art. 41.1 of the ICBN. Ambuchananiaceae is validated here.[2]

Ambuchananiaceae Seppelt & H.A.Crum, *fam. nov.*

Type: *Ambuchanania* Seppelt & H.A.Crum

Sphagnaceae similis sed caulibus cum cortice parce differentis sine poris aut fibrillis; foliis limitatis ab seriebus numerosis cellularum angustarum; cellulis hyalinis uni- vel bistratis; cellulis chlorophyllosis adaxialis; archegoniis terminalibus, cum foliis perichaetialis amplificatis; antheridiis nudis, oblongis-cylindricis differt.

ANDREAEACEAE

Barbara M. Murray[3]

Andreaea erubescens Müll.Hal., *Hedwigia* 37: 79 (1898)

T: Mt Wellington, Tas., Jan. 1889, *W.A.Weymouth s.n.*; lecto (here chosen): H-BR ex Herb. C.Müller.

The text of the handwritten label is: Andreaea erubescens n. sp./Tasmania, Mt. Wellington: / F.M.Weymouth./Hb. C Müll. Other Weymouth material labelled *A. erubescens* from Mt Wellington has collection dates of 2 Jan. 1888 (CHR, FH, H-BR) and Jan. 1888 (S).

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[2] The editor is grateful to Dr Niels Klazenga and Dr Tom May for nomenclatural advice.

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Andreaea erubescens Müll.Hal. var. *nigrita* Müll.Hal., *Hedwigia* 37: 79 (1898)

T: Mt Wellington, Tas., Jan. 1889, *W.A.Weymouth s.n.*; lecto (here chosen): H-BR ex Herb. C.Müller.

The text of the handwritten label is: Andreaea subulifolia n. sp./Tasmania, Mt. Wellington./ F. M. Weymouth leg/ Hb C. Müll. Other Weymouth material labelled *A. subulifolia* (*nom. inval*.) from Mt Wellington is dated 2 Jan. 1888 and has a collection number *263* (BM, CHR, FH, H-BR, HO).

Andreaea attenuata Müll.Hal., *Hedwigia* 37: 84 (1898)

Andreaea amblyophylla var. *attenuata* (Müll.Hal.) Rodway, *Pap. & Proc. Roy. Soc. Tasmania* 1913: 151 (1914). T: Mt Wellington, Tas., 1 Sept. 1891, *W.A.Weymouth 764 p.p.*; lecto (here chosen): H-BR; isolecto: HO 72278 *p.p.*

The protologue gives the name as "Andreaea attenuata C. Müll. in Hb. Burchard, 1891". The only material I have seen is mixed with material of *A. julicaulis* Müll.Hal. There is a packet in H-BR with the text as follows: Musci Tasmanici/Andreaea julicaulis/n.sp./ "+ A. attenuata, B., n. sp/(foliis attenuatis cuspidatis)."/In rocks known as the Ploughed/Field, Mt. Wellington, 1/9/91/alt. 4000'/W. A. Weymouth/764"

This packet contains two smaller packets. One, labelled 764, contains a mixture of mostly *A. acutifolia* (= *A. attenuata*) and a little *A. mutabilis* (= *A. julicaulis*). The other packet has more information: A. julicaulis mihi n. sp./Tasmania, Ploughed Fields, on rocks/on Mt Wellington/alt: 4000 ft com. Dr O Burchard 263/1.IX.91. This contains mostly *A. mutabilis* with a small amount of *A. acutifolia*. It is chosen here as the lectotype of *A. julicaulis* (see below).

In order to delimit the lectotype of *A. attenuata*, I have removed material from the packet labelled 764 in H-BR which is referable to *A. acutifolia* and placed it in a smaller packet on which I have written its status.

A similar packet in HO (72278) has *A. julicaulis* and *A. attenuata* listed on the label, and it contains several paper fragments annotated "764". The material is mostly *A. acutifolia*, with some *A. mutabilis*.

Andreaea amblyophylla Müll.Hal ex Broth., *Öfvers. Förh. Finska Vetensk.-Soc.* 37: 149 (1895)

T: Knocklofty, N of Salvator Rosa Glen, near Hobart, Tas., 19 Aug. 1893, *W.A.Weymouth 1618*: lecto (here chosen): H-BR; isolecto: BM, NSW 211189, NSW M11165, NY; Blue Mtns, N.S.W., *T.Whitelegge 302*; syn: H-BR, MEL, NSW; Knocklofty, near Hobart, Tas., *W.A.Weymouth 262*; syn: BM, H-BR, HO; *loc. id., W.A.Weymouth 475*; syn: BM, CANB, H-BR, HO; *loc. id., W.A.Weymouth 476*; syn: H-BR, HO; *loc. id., W.A.Weymouth 477*; syn: CANB, H-BR, HO; *loc. id., W.A.Weymouth 1618(a*); syn: H-BR; Mt Wellington, Tas., *W.A.Weymouth 1634*; syn: H-BR; *loc. id., W.A.Weymouth 1635*; syn: BM, H-BR, HO; *loc. id., W.A.Weymouth 1643*; syn: H-BR, HO.

From several suitable syntypes, I have chosen an ample, representative specimen with replicates in several herbaria.

Andreaea flexuosa R.Br.bis, *Trans. Proc. New Zealand. Inst.* 25: 279, pl. 23 (1893)

T: Moa Creek, New Zealand, June 1885, *R.Brown*; lecto (here chosen): BM-Dixon; Arthur's Pass, New Zealand, June 1884, *R.Brown*; syn: *n.v.*

The protologue cites a second collection by Brown: Arthur's Pass, on rocks, June 1884. However, I have seen no Brown *Andreaea* collections from that locality.

The BM-Dixon specimen from Moa Creek comprises two small tufts glued to a herbarium sheet with a label as follows: Herb. H. N. Dixon/Ref. No. 2a/Andreaea petrophila Ehrh./Moa Creek, N. Z./R. Brown ter./June 1885/comm. G Brown/Det. H.N.D. To the left is a hand-written annotation: "This is probably the co-type of A. flexuosa R. Br. ter./H.N.D." There is also a partly glued annotation slip in Brown's hand: "more flexious leaved var of No. 2."

A second Brown specimen from Moa Creek (CHR 335642 transferred from CANTY in May 1975) is labelled in an unknown hand: Andreaea flexuosa, R. Brown, cotype/Moa Creek/ R. Brown col. I have identified it as *Andreaea wrightii* R.Br.bis, which may be a synonym of *A. flabellata* Müll.Hal.

Andreaea huttonii R.Br.bis, *Trans. & Proc. New Zealand Inst.* 25: 279, t. 23 *p.p.* (1893), as *huttoni*

T: Moa Ck, New Zealand, June 1885, *R.Brown*; lecto (here chosen): BM-Dixon; isolecto: BM-Dixon, BM ex Cardot, CHR 335634 transferred to CANB, H-BR.

The lectotype consists of two tufts glued to the herbarium sheet and a small packet with loose fragments glued to the right of the tufts. A label handwritten in red ink is attached below the plants. Elsewhere on the sheet is a note by Dixon explaining that notes in red ink are by Brown. Brown's label reads "Andreae Huttonii. Hab Moa creek tributary of the Wilberforce/colector [sic] June X 1885 – R B." The specimen was sent to Dixon by W.A.Weymouth. Dixon also noted the following "See letter of W.A.Weymouth and Brown's letters + drawings to him."

Isolectotypes are present in BM-Dixon, CHR (335634) and H-BR. The last is in a printed newsprint packet with pin holes in it. A label inside the packet in Brown's hand states "Andreae Huttonii." Professor Timo Koponen, Helsinki, sent a note along with the loan explaining that the specimen was from Brown's herbarium. Koponen wrote, "It is characteristic of R.Brown III's specimens to have needle pits (he was a shoemaker). According to a letter to Brotherus, R.B. sent specimens to him".

Andreaea microvaginata Müll.Hal., *Hedwigia* 37: 80 (1898)

T: Kelly's Ra., Westland, South Is., New Zealand, 10 May 1889, *T.W.N.Beckett s.n.*; lecto (here chosen): H-BR ex Herb. C.Müller; isolecto: S.

The handwritten label of the specimen chosen is as follows: Andreaea micro-vaginata/n sp./ Nova Seelandia, Kelly's Range/Westland: Beckett 1899 lg./Hb. C. Müll. The specimen consists of two small tufts, and no sporophytes are present.

There is no specimen in Beckett's herbarium (CHR), although there is a sheet of tissue with the following information: Andreaea (B)/Lake. Kellys R/10 V 89/224/Sent to Dr. K. Muller/ Andreaea micro vaginata.

Andreaea tasmanica Rodway, *Pap. & Proc. Roy. Soc. Tasmania* 1915: 95 (1916)

T: Cradle Mtn, Tas., Dec. 1915, *L.Rodway s.n.*; lecto (here chosen): HO 74062; syn: HO 522113.

An outer packet in HO 74062 originally contained three smaller packets. All were collected in Dec. 1915 at Cradle Mtn, and all are referable to *A. microvaginata* Müll.Hal. (= *A. tasmanica*). The lectotype is the packet with the following annotation that closely matches much of the original description: "Leaves linear nerveless. Cuticle smooth. Leaves of young shoots closely appressed, very broadly oblong with a short reflexed apex, margin armed with prominent papillae". The two remaining packets that are here designated isolectotypes have been segregated (HO 522113) (Lynette Cave, *in litt.*, 9 Nov. 2005).

Although *A. tasmanica* was described as having nerveless leaves, they are, in fact, costate.

Andreaea julicaulis Müll.Hal., *Hedwigia* 37: 79 (1898)

T: Mt Wellington, Tas., 1 Sept. 1891, *W.A.Weymouth 263 p.p.*; lecto (here chosen): H-BR.

The protologue gives the name as "Andreaea julicaulis C. Müll. in Hb. Burchard, 1891". See discussion above under *A. attenuata* Müll.Hal. The lectotype contains mostly *A. mutabilis* (= *A. julicaulis*) along with a small amount of *A. acutifolia* (= *A. attenuata*).

Andreaea tenera Müll.Hal., *Hedwigia* 37: 84 (1898)

T: Nellies Glen, Katoomba, Blue Mtns, N.S.W., 5 Oct. 1891, *T.Whitelegge 430*; lecto (here chosen): H-BR; isolecto: NSW M11168, S.

The protologue gives the name as "Andreaea tenera C. Müll. In Hb. Brotheri." The lectotype has a note in Brotherus' hand "det. C. Müller."

Andreaea amblyophylla var. *bullata* Rodway, *Pap. & Proc. Roy. Soc. Tasmania* 1913: 151 (1914)

T: Mt Wellington, Tas., Dec. 1913, *L.Rodway s.n.*; lecto (here chosen): HO 72280 *p.p.*

The protologue gives no date of collection. The specimen HO 72280 includes material labelled *A. amblyophylla* var. *bullata* which is here chosen as the lectotype, and material labelled *A. amblyophylla* var. *attenuata* which is excluded.

Andreaea nitida Hook.f. & Wilson, *London J. Bot.* 3: 535 (1844)

T: Auckland Is., 1839–43, *J.D.Hooker 52*; lecto (here chosen): BM-Wilson; isolecto: BM, FH; isolecto: BR, E *n.v.*, *fide* W.Schultze-Motel, *Willdenowia* 6: 90 (1970).

The number 52 is a Wilson number, designated by a W in front of the number on some specimens. The lectotype, chosen from several in Wilson's herbarium, is adjacent to copied descriptions similar to the original, published description.

POLYTRICHACEAE

Jaakko Hyvönen[1]

Polytrichum sullivanii Hampe, *Linnaea* 40: 316 (1876)

T: between Mt Ararat and Mt William, Vic., *D.Sullivan*; lecto (here chosen): H-BR; isolecto: BM, MEL.

Polytrichum cypellomitrium Müll.Hal., *Hedwigia* 36: 343 (1897)

T: Kangaroo Valley, near Moss Vale, N.S.W., Dec. 1885, *T.Whitelegge*; lecto (here chosen): H-BR; Moss Vale, Fitzroy Falls, N.S.W, Nov. 1884, *coll. unknown*; syn: H, MEL, NSW, S.

Polytrichum tysdalei Müll.Hal., *Hedwigia* 36: 346 (1897)

T: Gippsland, Vic., 1884, *H.Tysdale*; lecto (here chosen): H-BR; isolecto: JE.

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SPLACHNOBRYACEAE

Bernard Goffinet[1]

Splachnobryum baileyi Broth., *Bot. Zentralbl.* 36: 85 (1888)

T: "ubi ad Brisbane River", Qld, *F.M.Bailey*; lecto (here chosen): S; isolecto: CHR.

SPLACHNACEAE

Bernard Goffinet

Tayloria callophylla (Müll.Hal.) Mitt., *Trans. & Proc. Roy. Soc. Victoria* 19: 65 (1882)

Dissodon callophyllus Müll.Hal., *Bot. Zeitung (Berlin)* 9: 546 (1851); *Splachnum callophyllum* (Müll.Hal.) Wilson, *in* J.D.Hooker, *Fl. Tasman.* 2: 198 (1859). T: "Terra van Diemen, ad truncos et terra humida loco 'Stern tree valley' montis Welligton nuncupati" [Mt Wellington, Tas.], 1850, *S.Mossman 824*; lecto (here chosen): NY; isolecto: BM, JE; para: *S.Mossman 824* (BM, E?, NY).

Tayloria gunnii (Wilson) J.H.Willis, *Victorian Naturalist* 67: 30 (1950)

Splachnum gunnii Wilson, *London J. Bot.* 7: 26, t. 1B (1848). T: On dead fern trees, Acheron River, Tas., *R.C.Gunn 1625*; lecto (here chosen): BM; isolecto: BM, NY, PC.

Tayloria obtusissima Broth., *Oefvers. Förh. Finska Vetensk.-Soc.* 37: 164 (1895)

T: Falls Track, Mt Wellington, Tas., *W.A.Weymouth 1797*; lecto (here chosen): H-BR; isolecto: BM, CHR, NY.

Tayloria octoblepharum (Hook.) Mitt., *Trans. & Proc. Roy. Soc. Victoria* 19: 65 (1882)

Splachnum octoblepharum Hook., *Musc. Exot.* 2: 167 (1819); *Eremodon octoblepharum* (Hook.) Hook.f., *Fl. Nov.-Zel.* 2: 94 ('1855') [1854]; *Dissodon octoblepharum* (Hook.) Paris, *Index Bryol.* 385 (1896). T: "In truncis arborum emortuarum in Insula Van Diemen" [Tas.], *R.Brown*; lecto: BM (here chosen) [2 duplicates]; isolecto: BM, E, G.

Splachnum octoblepharum Hook. var. *pyriforme* Hook.f. & Wilson, *Fl. Antarct.* 1: 123 (1844)

Dissodon plagiopus (Mont.) Müll.Hal. var. *pyriformis* (Hook.f. & Wilson) A.Jaeger, *Ber. Tätigk. St. Gallischen Naturwiss. Ges.* 1872–73: 194 (1874); *Tayloria octoblepharum* (Hook.) Mitt. var. *pyriformis* (Hook.f. & Wilson) Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 108 (1906). T: Campbell's Island, *[J.D.]Hooker*; lecto (here chosen): NY.

Splachnum octoblepharum Hook. var. *major* Hook.f. & Wilson, *Fl. Antarct.* 1: 124 (1844)

Dissodon plagiopus (Mont.) Müll.Hal. var. *major* (Hook.f. & Wilson) A.Jaeger, *Ber. Tätigk. St. Gallischen Naturwiss. Ges.* 1872–73: 194 (1874); *Tayloria octoblepharum* (Hook.) Mitt. var. *major* (Hook.f. & Wilson) Watts & Whitel., *Proc. Linn. Soc. New South Wales* 30 (Suppl.): 108 (1906). T: Campbell's Island, *[J.D.]Hooker*; lecto (here chosen): NY.

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Tayloria purpurascens (Hook.f. & Wilson) Broth., *Nat. Pflanzenfam.* I, 3: 502 (1903)

Splachnum purpurascens Hook.f. & Wilson, *London J. Bot.* 3: 539 (1844). T: "Campbell's island [Campbell Is.]; in moist bogs, amongst grass; altitude 1000 feet", *J.D.Hooker*; lecto (here chosen): BM; isolecto: BM [4 duplicates], E.

ORTHOTRICHACEAE

Helen P. Ramsay[1]

Ulota laticiliata Malta, *Acta Horti Bot. Univ. Latv.* 7: 11 (1933)

T: Recherche Bay, Tas., 17 Jan. 1911, *W.A.Weymouth 2487*; lecto (here chosen): H-BR; isolecto: HO; Mt Wellington, Tas., 6 Mar. 1891, *W.A.Weymouth 227*; syn: H-BR; isosyn: HO.

Malta based his descriptions on two specimens (*W.A.Weymouth 2487* and *227*), but he did not specify a holotype. He also examined some New Zealand collections. His drawings of the peristome (Malta, *op. cit.* 12) were based on *Weymouth 2487*. An isosyntype of this specimen which agrees with the description has been located in HO.

Ulota viridis var. **dixonii** (Malta) H.P.Ramsay, *comb. nov.*

Basionym: *Ulota dixonii* Malta, *Acta Horti Bot. Univ. Latv.* 7: 19 (1933).

BRYACEAE

John R. Spence[2] *& Helen P. Ramsay*

Bryum calodictyon Broth., *Proc. Linn. Soc. New South Wales* 41: 589 (1916)

T: Green Gully, near Young, N.S.W., *W.W.Watts 7244*; lecto (here chosen): H-BR; back of cemetery, Young, N.S.W., *W.W.Watts 7244*; syn: NSW.

Gemmabryum pachythecum (Müll.Hal.) J.R.Spence & H.P.Ramsay, *Phytologia* 87: 64 (2005)

Bryum pachytheca Müll.Hal., *Syn. Musc. Frond.* 1: 307 (1848). T: York, W.A., 10 Sept. 1839, *L.Preiss 2466*; lecto (here chosen): BM; isolecto: MEL 30783; India Orientalis, Herb. Gottscheanum; syn: L.

Plagiobryum cellulare (Hook.) J.R.Spence & H.P.Ramsay, *comb. nov.*

Basionym: *Bryum cellulare* Hook., *Sp. Musc. Frond.*, Suppl. 3, 1: 214 (1827).

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Bryum chlororhodon Müll.Hal., *Hedwigia* 37: 107 (1898)

T: Dimboola, Vic., July 1896, *F.M.Reader s.n.*; lecto (here chosen): MEL; isolecto: MEL; Dimboola, Vic., July 1896, *F.M.Reader 16*; syn: NSW.

GLOSSARY

Compiled by Helen P. Ramsay[1]

abaxial: *of the side or surface of an organ*, facing away from the axis. cf. **adaxial**.

acaulescent: lacking a stem.

acrocarpous: with the gametophyte producing the sporophyte at the end of the stem or main branch. Most acrocarpous mosses grow erect in tufts, and they are not or only sparsely branched. cf. **pleurocarpous**.

acumen: a slender, tapering point. adj. **acuminate**.

acute: terminating in a distinct but not protracted point, the converging edges separated by an angle of 45–90°.

adaxial: *of the side or surface of an organ*, facing towards the axis. cf. **abaxial**.

alar cells: specialised cells at the basal angles of a leaf, often distinctive in their size, shape, colour or ornamentation.

amphigastria (sing. **amphigastrium**)**:** leaves that grow in a row on the lower side of a stem and which are usually smaller and have a different shape to other leaves.

amphithecium: the outer embryonic tissue of an embryonic capsule surrounding the central **endothecium**; gives rise to all tissues from the epidermis to the outer spore sac; also produces the spore sac in *Sphagnum*.

amplexicaul: clasping a stem.

analogous: structures or organs with similar functions that do not have a common phylogenetic origin; e.g. stomata and air pores. cf. **homologous**.

androecium (pl. **androecia**)**:** the "male gametoecium" consisting of antheridia, paraphyses and surrounding bracts. See also **perigonium**.

aneuploidy: having a chromosome number that differs from the basic euploid number by the loss or addition of 1 or more chromosomes, e.g. in mosses the haploid number is $n + 1$ or $n - 1$, as opposed to polyploidy where the chromosome number is a multiple of the haploid number, e.g. $2n$, $3n$, $4n$.

anisomorphic: describing related structures that exhibit more than one distinct type of size or shape.

anisophyllous: having dissimilar stem and branch leaves. e.g. in *Sphagnum* and *Thuidium*; or bearing two distinct types of leaves on the same stem, e.g. in *Hypopterygium* and *Racopilum*.

annual: a plant that completes its life history within one year.

annular: shaped like a ring; leaves or branches arranged in a circle, e.g. *Philonotis*.

annulus: one or more rings of enlarged, specialised cells between the mouth of the capsule and operculum, aiding in dehiscence.

antheridium (pl. **antheridia**)**:** the male gametangium; a multicellular stalked, structure with a jacket of sterile cells and producing large numbers of antherozoids (male gametes); globose to broadly cylindrical in shape.

[1] c/- National Herbarium of New South Wales, Royal Botanic Gardens and Domain, Mrs Macquaries Road, Sydney, New South Wales 2000.

antherozoid: a motile male gamete; in mosses propelled by two flagellae.

anticlinal: oriented perpendicular (rather than parallel) to the surface. cf. **periclinal**.

apical cell: a single cell at the apex of a shoot, leaf or other organ that divides repeatedly to produce new leaves, stems or other organs.

apiculus: a short, abrupt point; adj. **apiculate**.

apophysis (pl. **apophyses**)**:** a differentiated sterile neck at base of the capsule, between the seta and urn; sometimes swollen or expanded (= **hypophysis**).

apoplastic movement: the movement of water into a cell via the protoplast, being controlled by osmosis.

appendiculate: having short, thin transverse projections, e.g. on the endostomial cilia of the peristome (see **trabeculae**).

appressed: closely applied, as for leaves lying closely or flat against the stem.

archegonium (pl. **archegonia**)**:** the female gametangium; a multicellular, flask-shaped structure consisting of a stalk, a swollen base (venter) containing the egg and a neck through which the antherozoid swims to fertilise the egg.

arcuate: curved like a bow.

areolate: with small angular areas forming a network; the cellular pattern of the moss leaf is often termed **areolation**.

arista: the hard awn or bristle at the tip of a leaf, usually formed by an excurrent costa. adj. **aristate**.

arthrodontous: *of a peristome*, of triangular or linear teeth/segments consisting of differentially thickened wall-pairs. The teeth/segments are formed of part cells, in contrast to a **nematodontous** peristome in which they are formed of whole cells.

ascending: sloping or curved upwards.

attenuate: tapering gradually.

auricle: a small bulge or ear-like lobe at the basal margin of a leaf, e.g. in *Papillaria* and *Calyptothecium*; adj. **auriculate**.

autoicous: with male and female gametoecia on separate stems or separate branches of the same plant (**monoicous**). cf. **synoicous**, **paroicous**, **dioicous**.

awn: an arista or hairpoint, usually hyaline and formed of a projecting costa.

axil: the angle between the stem and any organ originating from it, e.g. a leaf or branch. adj. **axillary**.

axillary hair: a hair originating in a leaf axil, usually inconspicuous and often concealed by the leaf base.

axis: the main stem; the conceptual line around which leaves, branches and other organs develop.

basal membrane: a delicate or robust membrane at the base of the endostome, often bearing segments and cilia (= **basement membrane**).

basement membrane: see **basal membrane**.

bifurcate: forked into ±equal parts.

bistratose: consisting of two cell layers, e.g. a leaf lamina two cells thick.

border: *of leaves or the edges of peristome teeth*, a margin that is differentiated in shape, size, colour or thickness. adj. **bordered**.

bract: one of the specialised leaves surrounding and protecting archegonia and/or antheridia.

bryophyte: a non-vascular, green plant with a gametophyte generation that is free-living and a comparatively ephemeral sporophytel; a collective name for mosses, liverworts and hornworts.

bulbil: a small deciduous, bulb-shaped, axillary, vegetative propagule or rhizoidal gemma; often with rudimentary leaves.

bulbiform: bulb-shaped.

caducous: falling readily or early.

caespitose: tufted, growing in dense cushions or turfs.

calcicolous: a plant that grows best in habitats or on substrata with high levels of calcium.

calcifugous: a plant that cannot tolerate habitats or substrata with high levels of calcium.

calyptra (pl. **calyptrae**)**:** a membranous or hairy hood or covering that protects the maturing sporophyte; derived largely from the archegonial venter.

campanulate: shaped like a bell; here referring to a calyptra that is elongated and somewhat cylindrical; a campanulate-cucullate calyptra is split on one side only, whereas a campanulate-mitrate calyptra is undivided or equally lobed at the base.

capitulum (pl. **capitula**)**:** a head-like mass of crowded branches at the apex of the stem, e.g. in *Sphagnum*.

capsule: the terminal, spore-producing part of a moss sporophyte.

carinate: folded along the middle, like the keel of a boat; V-shaped in cross-section.

caulonema: a secondary, bud-generating part of the filamentous moss **protonema**, typically reddish brown with few chloroplasts and consisting of long cells with oblique end walls.

central strand: the column of elongated cells, sometimes with thicker walls, in the centre of a stem.

cernuous: nodding or drooping.

channelled: *of a leaf*, hollowed out like a gutter and semicircular in cross-section.

chloronema: the filamentous part of the protonema that contains chloroplasts.

cilia (sing. **cilium**)**:** a delicate, hair-like or thread-like structure, usually one cell thick and unbranched; in peristomes, a structure that occurs singly or in groups alternating with the segments of the inner endostome; hair-like appendages fringing leaves or calyptrae. adj. **ciliate**.

cladocarpous: having perichaetia terminal on lateral branches with juvenile leaf development similar to that on vegetative branches, in e.g. *Macromitrium* and *Schlotheimia*.

clavate: club-shaped.

cleistocarpous: *of a capsule*, lacking an operculum and, therefore, opening irregularly.

clone: population of genetically identical plants produced vegetatively from a single propagule or spore.

cochleariform: round and deeply concave, like the bowl of a spoon.

collenchymatous: cells with walls that are thickened at the corners, e.g. exothecial cells or cortical cells of stems seen in cross section.

columella: the sterile, central tissues of a moss capsule.

commissure: the margin of a hyaline cell which adjoins that of a chlorophyllose cell in the leaves of *Sphagnum* spp.

comose: stems tips with leaves that are larger and crowded into tufts (**comae**), e.g. in *Bryum* and *Campylopus*.

compensation point: the point at which energy lost through cellular respiration equals that gained through photosynthesis.

complanate: a leafy shoot that is more-or-less flattened into one plane.

complicate: folded lengthwise.

concolorous: having the same colour.

conduplicate: folded lengthwise along the middle.

conspecific: belonging to the same species.

constricted: abruptly narrowed.

contracted: abruptly narrowed or shortened.

convolute: *of leaves or bracts*, rolled together to form a sheath, e.g. the perichaetial leaves of *Holomitrium*.

cordate: heart-shaped, as in leaves attached at the broad end.

coriaceous: leathery in texture.

cortex: the outermost layer or layers of cells in a stem, often differentiated from the central cylinder. adj. **corticate**, **cortical**.

corticolous: growing on bark.

costa (pl. **costae**)**:** the thickened midrib or nerve of a leaf; when present, can be single or double. adj. **costate**.

crenate: *of a leaf margin*, having rounded teeth.

crenulate: *of a leaf margin*, having minute, rounded teeth formed from bulging cell walls.

crisped (or **crispate**)**:** wavy; often used loosely to include curled, twisted and contorted.

cristate: having a crest-like ridge.

cucullate: hooded or in the shape of a hood; applied to leaves that are concave at the tips and to calyptrae that are conical and split up one side.

cushion: a more-or-less hemispherical or rounded moss colony, with stems generally erect and tightly clustered but radiating somewhat to form a tuft.

cuspidate: ending in a stout, rigid point, like a tooth.

cuticle: a non-cellular coating on the outer surface of cells in contact with the environment, often variously roughened or ornamented.

cygneous: curved downwards in the upper part like the neck of a swan, e.g. setae of *Campylopus*.

cylinder: the central strand in stem. adj. **cylindrical**.

cymbiform: concave and boat-shaped.

deciduous: falling off, lost at maturity, e.g. the operculum.

decumbent: tips ascending from a prostrate base.

decurrent: applied to the margins of leaves which extend down the stem, as ridges or narrow wings, below the insertion of the leaf.

decurved: curved downward.

deflexed: bent downward.

dehiscent: *of capsules*, splitting open by means of an annulus, operculum or valves (as opposed to **indehiscent**).

dendroid: with the habit of a tree, branching from a main stem, e.g. *Hypnodendron* and *Hypopterygium* (cf. **frondose**).

dentate: with teeth directed outward.

denticulate: with fine teeth.

depauperate: stunted or poorly developed.

depressed: flattened, as viewed from above.

descending: directed gradually downward.

diaspore: an agent of dispersal; any structure that becomes detached from the parent plant and gives rise to a new individual.

dichotomous: with two equal forks or branches.

differentiation: the morphological and physiological changes that occur between initiation and maturation of a cell, tissue or organ.

dimorphic: of two distinct forms, e.g. leaves, male and female plants.

dioicous: with archegonia and antheridia borne on separate plants. [Not the same as dioecious.]

diploid: a cell, individual or generation with two sets of chromosomes ($2n$); the typical chromosome level of the sporophyte generation.

diplolepidous: a form of arthrodontous peristome having two concentric rings of teeth, with the outer ring (**exostome**) derived from thickening of the contiguous walls of the outer and primary peristomial layers and the inner ring (**endostome**) derived from the thickening of the contiguous walls of the primary and inner peristomial layers. The exostome is generally more heavily thickened than the endostome. One or both rings may be absent or reduced (cf. **haplolepidous)**.

distal: away from the base or point of attachment; the converse of **proximal**.

distant: widely spaced, e.g. leaves with space between adjacent leaves.

distichous: leaves alternating in two opposite rows on a stem, as in *Fissidens*.

divergent: spreading in opposite directions.

dorsal lamina: part of the leaf blade opposite the sheathing base, at the back of the costa and below the apical lamina in *Fissidens*.

dorsiventral: flattened with distinct upper and lower surfaces.

dwarf male: a minute male gametophyte borne on the female plant.

echinate: bearing spiny projections.

ecostate: lacking a costa.

ectohydric: having water transport essentially external by surface flow, including capillary motion between leaves or through surface papillae. cf. **endohydric**.

efibrillose: without fibrils.

ellipsoidal: a solid with an elliptical profile.

elliptical: having the shape of an ellipse, oblong but convex at the sides and ends.

emarginate: broad at the apex with a shallow notch, deeper than **retuse**.

embryo: the developing sporophyte phase normally generated from a zygote; in mosses it usually consists of a foot, seta and capsule.

emergent: partly exposed, as a capsule only partly protruding from among the perichaetial leaves. cf. **exserted**, **immersed**.

endemic: restricted to one country or one floristic region.

endohydric: having water transport essentially internal. cf. **ectohydric**.

endostome: the inner ring of a diplolepidous peristome, formed from contiguous periclinal wall-pairs of the primary and inner peristomial layers; typically a weak membranous structure consisting of a basal membrane bearing **segments** and **cilia**; homologous with the single peristome of haplolepidous mosses.

endothecium: in most mosses, the inner embryonic tissue of a capsule which gives rise to all tissues interior to the outer spore sac. In *Sphagnum* it also produces the columella.

entire: with a smooth outline, not toothed or lobed.

ephemeral: short-lived.

epidermis: the outer layer of cells at the surface of an organ, e.g. **exothecium**.

epiphragm: a circular membrane, positioned horizontally over the capsule mouth of some mosses, attached to the tips of the peristome teeth and partially closing the mouth of an inoperculate capsule, e.g. *Funaria*, *Polytrichum*.

epiphyllous: a plant that grows on the living leaves of another plant.

epiphyte: a plant that grows on the surface of another plant.

equidistant: regularly separated or spaced.

erect: *of leaves*, almost or quite parallel to the stem, but not appressed; *of branches or stems*, in a ±vertical position with respect to stem or substratum; *of capsules*, upright.

erecto-patent: spreading at an angle of less than 45°. cf. **spreading** or **patent**.

eukaryote: any cell or organism composed of cells that possess a membrane-bound nucleus, several chromosomes, cellular organelles and accomplishes cell division by mitosis and meiosis. adj. **eukaryotic**.

exannulate: lacking an annulus.

excavate: hollowed out.

excurrent: *of a costa*, extending beyond the leaf apex.

exine: the outermost wall layer of the spore.

exostome: the outer circle of the diplolepidous peristome, consisting of teeth formed from contiguous periclinal wall-pairs of the outer and primary peristomial layers; absent or rudimentary in the haplolepidous peristome.

exothecium: the epidermis or superficial layer of cells (**exothecial** cells) of the capsule wall.

exserted: exposed, as in a capsule protruding beyond the perichaetial leaves. cf. **emergent**.

failing: *of a costa*, terminating below the leaf apex.

falcate: curved like a sickle.

falcate-secund: strongly curved and turned to one side.

fascicle: a group, bunch or tuft of branches, e.g. in *Sphagnum*. adj. **fasciculate**.

fastigiate: with branches erect and of similar length.

fenestrate: pierced with broad openings resembling windows.

fibril: a fine, fibre-like wall thickening. adj. **fibrillose**.

filamentous: thread-like.

filiform: slender and elongate, thread-like.

fimbriate: fringed, generally eroded with radiating cell walls of partly eroded marginal cells. cf. **laciniate**.

flabellate: shaped like a fan.

flaccid: soft and limp.

flagelliform: whip-like; a branch with a gradual attenuation from ordinary leaves at the branch base to vestigial-branched tip. cf. **stoloniferous**.

flagellum (pl. **flagella**)**:** a slender, tapering branch; also the organs of locomotion in an antherozoid; adj. **flagellate**.

flexuose: slightly bent, wavy or twisted.

foliose: leafy or leaflike; covered with leaves.

foot: the basal organ of attachment and absorption for the bryophyte sporophyte, embedded in the gametophyte.

fringed: with a short-ciliate margin or edge.

frond: the branched or leafy part of an erect stem, including branches of a dendroid moss. adj. **frondose**.

fruit: archaic term for the capsule or sporophyte.

fugacious: quickly or readily falling or vanishing.

funiculate: rope-like, e.g. of leaf arrangement in some *Macromitrium* spp.

fusiform: narrow and tapering at each end, spindle-shaped.

gametangium (pl. **gametangia**)**:** an **antheridium** or **archegonium**; a structure forming gametes (**ovum**, **spermatozoid)**.

gamete: a haploid reproductive cell, e.g. **spermatozoid**, **ovum**.

gametoecium: a gametangium together with its surrounding bracts (see **androecium**, **gynoecium**).

gametophore: loosely used for the leafy moss gametophyte plant developed from a protonema.

gametophyte: the haploid, sexual generation; in bryophytes the free-living, dominant generation.

gemma (pl. **gemmae**)**:** uni- or multi-cellular, globose, clavate, filiform, cylindrical or discoid structures, borne on the aerial part of the plant and functioning in vegetative reproduction.

gemmiferous: bearing gemmae.

geniculate: bent abruptly, as at the knee.

gibbous: swollen or bulging at one side.

glabrous: smooth, not papillose, rough or hairy.

glaucous: bluish green in colour or with a greyish or whitish bloom.

granulose: minutely grainy, roughened with minute blunt projections.

gregarious: growing close together in loose tufts or mats.

guard cells: specialised photosynthetic cells bordering the stoma on the capsule wall.

guide cells: large, rather thin-walled cells in the centre of the costa, usually best seen in transverse section.

gymnostomous: without a peristome, so that the mouth of the urn is naked.

habit: general appearance.

hairpoint: the hair-like and often colourless leaf tip, formed from an excurrent costa or a tapering of the leaf lamina.

haploid: a cell, structure or organism having a haploid set of chromosomes (n); e.g. the normal chromosome number of the gametophyte generation.

haplolepidous: a form of arthrodontous peristome having only one circle of teeth derived from thickening of the contiguous walls of the primary and inner peristomial layers.

hepatic: a member of Class Hepaticopsida; also known as liverworts.

heterochromatin: condensed regions of chromosomes that stain at interphase but are comparatively transcriptionally inactive.

heteroicous: having several forms of gametoecia on the same plant; also called polygamous, polyoicous.

heterolepidous: a form of arthrodontous peristome thought by some to be intermediate between **haplolepidous** and **diplolepidous**, e.g. in *Encalypta*.

heteromallous: pointing in various directions. cf. **homomallous**.

heteromorphic: having two or more different shapes or phases.

hoary: greyish or whitish, appearing frosted from numerous massed hairpoints.

homologous: structures or organs with a common phylogenetic or developmental origin, but not necessarily similar in appearance and/or function. cf. **analogous**.

homomallous: pointing in the same direction. cf. **heteromallous**.

hornwort: a member of Class Anthocerotopsida.

Hoyer's solution: a water-soluble medium used for making semi-permanent, microscopic preparations.

hyaline: colourless and transparent; commonly used with reference to cells that lack chloroplasts.

hyalocyst: a large, hyaline, water-storage cell in Sphagnopsida.

hyalodermis: in *Sphagnum*, an cortex of large, empty, colourless cells. adj. **hyalodermal**.

hydroid: a water-conducting cell in the central strand and/or costa of some mosses, e.g. Polytrichales.

hydrome: a sheath of hydroid cells in the central strand and/or costa of some mosses, e.g. Polytrichales.

hypnoid: having a complete peristome; occasionally used to refer to a moss with a pleurocarpous habit.

hypophysis: see **apophysis**.

imbricate: closely appressed and overlapping.

immarginate: *of a leaf*, lacking a border.

immersed: submerged below the surface; immersed capsules occur below the tips of the perichaetial leaves; immersed stomata have guard cells that are sunken below the surrounding exothecial cells.

inclined: applied to a capsule that is tilted between the vertical and horizontal.

incrassate: thickened, or with thick walls.

incumbent: lying against or leaning on something.

incurved: curved upward and inward, the opposite of **recurved**; applied to leaf margins and tips.

indehiscent: *of capsules*, lacking a distinct opening mechanism; spores shed by irregular rupture or breakdown of capsule wall, e.g. in *Archidium*.

inflated: swollen, puffed up.

inflexed: bent upward (adaxially) and inward, the opposite of **reflexed**; applied to leaves, leaf margins and peristome teeth.

initial: an undifferentiated, meristematic cell that divides to produce discrete organs, e.g. rhizoid initial, stem initial or leaf initial.

innovation: a new shoot; in acrocarpous mosses a subfloral branch formed after differentiation of the sex organs, usually from the gynoecium base.

inoperculate: lacking an operculum.

insertion: a line or point of attachment of a leaf, branch or peristome etc.

intine: the innermost wall of the spore.

intramarginal: submarginal; structures close to or associated with but not strictly on the margin.

intricate: tangled, interwoven.

involute: strongly rolled upward (adaxially) and tightly inward, opposite of **revolute**; applied to leaf margins.

isodiametric: about as long as broad and having the same dimensions in all directions; applied to square, rounded or hexagonal cells.

isomorphic: *of spores*, ±uniform in size.

isophyllous: having similar stem and branch leaves. cf. **anisophyllous**.

julaceous: smoothly cylindrical; applied to shoots with crowded, imbricate leaves.

juxtacostal: the part of a leaf lamina adjacent to the costa.

lacerate: deeply and irregularly cut or torn.

laciniate: dissected into fine, deep, often irregular divisions (**laciniae)**; fringed with cilia.

lamella (pl. **lamellae**)**:** a longitudinal chlorophyllose ridge or plate on the leaf blade of some mosses (e.g. Polytrichaceae); adj. **lamellate**; the plates of the secondary wall deposition occurring between trabeculae on the dorsal and ventral surfaces of an arthrodontous peristome.

lamina (pl. **laminae**)**:** the blade of a leaf excluding the costa and leaf margin or border.

laminal cell: any cell of the lamina.

lanceolate: shaped like the blade of a spear, narrow and tapered from near the broader base.

lax: soft or loose, commonly referring to a tissue of large, thin-walled cells as well as the spacing of leaves.

lenticular: shaped like a double-convex lens.

leptoid: a conducting cell similar in form and function to a sieve tube in vascular plants; found in the central strand and setae of Polytrichales and in the setae of many mosses.

leptome: a tissue, similar to the phloem of vascular plants, consisting of leptoids and parenchymatous cells.

leucocyst: a large, empty hyaline cell in the leaves of Sphagnopsida and *Leucobryum* (= **hyalocyst**).

lid: operculum.

ligulate: strap-shaped, with parallel sides and an abruptly tapered apex.

limb: the upper part of the leaf, the lower part being the **base**.

limbidium: a leaf border or differentiated margin in e.g. *Fissidens*.

linear: very narrow and elongate, with the sides nearly parallel; narrower than **ligulate**.

lingulate: tongue-shaped; broad with the sides ±parallel.

lumen (pl. **lumina**)**:** the cavity of a cell.

***m*-chromosome:** the smallest chromosome, less than half the length of other members of the chromosome complement; common in bryophytes.

macronema (pl. **macronemata**)**:** a large, branched rhizoid produced around branch primordia and at the base of buds.

mammilla (pl. **mammillae**)**:** a bulge on the surface of cell with a nipple-like tip. adj. **mammillose**.

mat: a densely interwoven, horizontal growth form, e.g. *Thuidium*.

median: central, in the middle; **median leaf cells** are those in the upper middle of the leaf or, in leaves with a costa, those located between the margin and costa about two-thirds of the way up the leaf.

meristem: a permanent or temporary zone of actively dividing undifferentiated cells which by, mitotic division, give rise to tissues and organs.

meiosis: the process of nuclear division by which a diploid nucleus yields 4 haploid nuclei; in mosses meiosis takes place in the spore sac of the capsule to produce 4 haploid spores.

mitrate: *of a calyptra*, conical and undivided or regularly lobed at the base.

monoicous: bisexual, having antheridia and archegonia on the same plant; includes **autoicous**, **synoicous** and **paroicous** [Not the same as monoecious].

monopodial: with the main stem having unlimited growth, and giving rise to numerous, secondary, lateral shoots or stems.

mucro: a short, abrupt point at the apex of a leaf (adj. **mucronate**), as in a leaf with a short-excurrent costa; **apiculate** is somewhat longer.

***n*:** the haploid, gametophytic chromosome number of an organism.

naked: lacking covering structures or ornamentation; e.g. without hairs or papillae, referring to smooth, glabrous calyptra.

neck: the sterile basal part of moss capsule; also the cylindrical upper part of an archegonium.

nematodontous: *of a peristome*, consisting of whole dead cells with ±evenly thickened walls, e.g. as in Polytrichaceae. cf. **arthrodontous**.

nodose: knotted, with small knob-like thickenings; e.g. endostomial cilia in Bryaceae. dim. **nodulose**.

nutant: nodding or drooping.

ob-: a prefix indicating inversion, as in **obovate**.

oblate: wider than long.

oblong: rectangular but, when applied to leaves, usually rounded at the corners.

obovate: with the profile of an egg, the broad end distal.

obtuse: broadly pointed, at an angle of greater than 90°; sometimes used loosely to indicate blunt.

ochraceous: brownish yellow.

operculum (pl **opercula**)**:** the lid covering the mouth of most moss capsules, becoming detached at maturity; usually separated from the mouth by an annulus. adj. **operculate**.

ovate: with the profile of an egg, the base broader than the apex and about twice as long as wide.

palmate: having radiating branches originating from a single point.

panduriform: shaped like the body of a violin.

papilla (pl. **papillae**)**:** a minute, solid protuberance from the surface of a cells (especially of leaves and spores) of various forms, commonly domed or spinose, simple or branched. adj. **papillose**.

paraphyllium (pl. **paraphyllia**)**:** a small, green, filiform, lanceolate or leaf-like scale borne superficially on the stems between branches of many pleurocarpous mosses, e.g. *Thuidium*; see also **pseudoparaphyllia**.

paraphyses (sing. **paraphysis**)**:** sterile hairs composed of uniseriate cells, coloured or hyaline, associated with antheridia and sometimes archegonia.

parenchyma: tissue of undifferentiated cells, usually isodiametric and thin-walled, usually not overlapping; adj. **parenchymatous**.

paroicous: with antheridia and archegonia in the same gametoecium but not mixed, the antheridia immediately below the perichaetium in the axils of leaves.

patent: used for leaves spreading at an angle of about 45°.

patulous: used for leaves spreading at an angle of 45–90°.

pellucid: clear, transparent or translucent.

pendant: drooping or hanging down, e.g. the capsules of *Bryum*; or stems that hang, e.g. *Papillaria*. (= **pendulous**).

percurrent: *of a costa*, extending up to but ceasing at the apex of a leaf.

perfect: a complete peristome; applied to diplolepidous peristomes with an endostome having both segments and cilia.

perichaetial leaf: a modified leaf surrounding the archegonia.

perichaetium: the female gametoecium, consisting of the sex organs and the perichaetial leaves surrounding them.

periclinal: oriented parallel (rather than perpendicular) to the surface. cf. **anticlinal**.

perigonial leaf: a modified leaf associated with and surrounding the antheridia.

perigonium: the male gametoecium, consisting of the sex organs and the perigonial leaves associated with them.

peristome: a circular structure generally divided into 4, 8, 16 or 32 teeth arranged in single or double (rarely multiple) rows around the mouth of the capsule and visible after dehiscence of the operculum.

peristomial formula: an equation indicating the peristomial number from the outer peristomial layer (OPL) to the inner peristomial layer (IPL), and indicating relative degree of wall thickening and any lateral displacement of the IPL and prostomial development.

peristomial number: the number of cell columns in the outer, primary and inner peristomial layers per 45° arc (one-eighth peristome).

peristomial cylinder: the three innermost layers of amphithecial tissue in an arthrodontous moss capsule which produce the peristome. The inner peristomial layer is proximally continuous with the outer spore sac; the middle and outer layers represent the primary and outer peristomial layers, respectively.

phaneropore: a superficial stoma in a capsule wall having the guard cells on the same level as the exothecial cells. adj. **phaneroporous**.

phyllodioicous: with dwarf male plants growing on the leaves or tomentum of much larger female plants.

piliferous: with a long hairpoint.

pinnate: with spreading branches on either side of a stem, rather like a feather.

pitted: *of a cell wall*, having small depressions or pores.

placenta: the interface between the gametophyte and sporophyte, usually containing numerous transfer cells. adj. **placental**.

plane: flat, not curved or wavy, as in leaf margins.

pleurocarpous: having sporophytes produced laterally on short, usually specialised branches rather than from the apex of the main stem; mosses with stems usually prostrate, creeping and freely branched, growing in mats rather than tufts. cf. **acrocarpous**.

plica: a lengthwise fold or pleat. adj. **plicate**.

plumose: closely and regularly pinnate and feathery in appearance.

polymorphic: having more than one form, variable.

polyploid: a plant or tissue with more than 2 complete sets of chromosomes.

polysety: having more than one sporophyte produced from a single gametoecium, each from a separate archegonium with its own calyptra, e.g. *Dicranoloma dicarpum*. adj. **polysetose**.

pore: a pit or opening in a cell wall. adj. **porose**.

primordial utricle: the collapsed contents of a cell that have separated from the cell wall.

process: the main divisions of a diplolepidous peristome (also called **segments**).

procumbent: prostrate, spreading.

prolate: longer than wide. cf. **oblate**.

propagule: a reduced bud, branch or leaf functioning in vegetative reproduction.

prora: a mammillose projection formed by protrusion of the end of a prosenchymatous cell. adj. **prorate**; dim. **prorulate**.

prosenchyma: a tissue consisting of narrow, elongate cells with overlapping ends. adj. **prosenchymatous**.

prostome: a rudimentary structure outside and usually adhering to the main peristome teeth; e.g. in Pterobryaceae.

prostrate: lying flat on ground; creeping.

protandrous: maturation of the antheridia prior to the archegonia.

protogynous: maturation of the archegonia prior to the antheridia.

protonema (pl. **protonemata**)**:** a filamentous, globose or thallose structure resulting from spore germination and including all stages up to production of one or more gametophores. The protonema varies in the amount of chlorophyll present and the degree of obliqueness of its end walls, and in its branching.

protuberant: projecting.

proximal: the end or part nearest to the base or place of origin. cf. **distal**.

pseudautoicous: having dwarf male plants epiphytic on the female.

pseudoparaphyllium (pl. **pseudoparaphyllia**)**:** structures resembling paraphyllia but restricted to the bases of branches and branch buds in some pleurocarpous mosses.

pseudopodium: an elongation of the stem of the gametophore, e.g. below the sporophyte in *Sphagnum* and *Andreaea*, to give a false seta; also an extension of the stem tip bearing clusters of gemmae, e.g. in *Trachyloma*.

pseudopore: a pore-like structure with a thin membrane that is revealed by staining; e.g. in the hyalocysts of some Calymperaceae; in *Sphagnum* leaves consisting of fibril rings without an interior perforation.

pulvinate: cushion-like.

punctate: minutely dotted.

pyrenoid: a usually spherical or ellipsoidal structure within the chloroplast visible under the light microscope; acts as a centre for carbohydrate (e.g. starch) synthesis.

pyriform: pear-shaped, e.g. the capsules of *Bryum*.

quadrate: *usually of cells*, appearing square or approximately so in two dimensions.

rachis: the axis of a pinnate or umbellate frond.

radiculose: covered with rhizoids.

ramification: branching.

ramose: richly branched.

recurved: curved down (abaxially) and inward, the opposite of **incurved**; in leaves referring to margins, apices or marginal teeth; in the peristome, teeth curved outward and ±downward.

reflexed: bent down (abaxially) and inward, the opposite of **inflexed**; generally referring to leaf margins or leaves of a stem.

reniform: kidney-shaped.

resorbtion: the digestion or erosion of cell walls in the leaves of some species of *Sphagnum*.

resorbtion furrow: a groove along the leaf margins of some species of *Sphagnum* caused by erosion of the outer cell walls.

reticulate: forming a network.

retort cells: cortical cells in some species of *Sphagnum*, with a downwardly projecting neck ending in a pore.

retuse: a slight indentation or notch in a broad, rounded apex.

revolute: *of leaf margins*, rolled downward (abaxially) and backward.

rhizautoicous: monoicous, with the male gametoecium on a short branch attached to the female plant by rhizoids and so appearing to be separate.

rhizoid: a hair-like structure that anchors a moss to the substratum; multicellular with oblique cross walls, often pigmented, and sometimes clothing the stem.

rhizome: a slender horizontal, subterranean stem giving rise to erect secondary stems; e.g. in *Dawsonia* and *Rhodobryum*.

rhombic: diamond-shaped.

rhomboidal: longer and narrower than rhombic, oblong-hexagonal.

rostellate: *of an operculum*, with a short beak.

rostrate: *of an operculum*, with an apical beak that is narrowed to a slender tip or point.

rosulate: resembling a rosette, with leaves enlarged and crowded at the tips of stems.

rugose: with irregular, roughly transverse wrinkles or undulations; e.g. the leaves of *Neckera*.

rugulose: minutely or somewhat wrinkled transversely.

saxicolous: growing on rock.

scabrous: rough.

scleroderm: a tissue of thick-walled cells in the central cylinder of stems and branches of *Sphagnum*.

secund: bent or turned to one side.

segment: *of a peristome*, a single, tooth-like component of the endostome.

seriate: in rows (uni-, bi-, tri- or multiseriate); applied either to adjacent rows of leaf cells, or to ranks of leaves on a stem. cf. **stratose**.

serrate: regularly toothed like a saw; leaves with marginal teeth pointing forward.

serrulate: minutely serrate.

sessile: without a stalk, e.g. of sporophytes with greatly reduced setae.

seta (pl. **setae**)**:** the elongated portion of the sporophyte between the capsule and the foot.

setaceous: bristle-like.

sheathing: surrounding or clasping a stem, seta or capsule.

shoulder: the distal part of the leaf base where it is abruptly narrowed to the upper lamina or limb.

sigmoid: S-shaped.

sinuose: having a wavy wall or margin.

sinus: a gap between two lobes of a leaf.

spathulate: having the shape of a spatula, narrow below and gradually broadening above.

spermatozoid: a male gamete; bearing two flagella.

spiculose: sharply and minutely toothed or papillose.

spinose: having sharply pointed teeth.

spinulose: with minutely sharply pointed teeth.

splash-cup: a cup-shaped androecium in which the dispersal of antherozoids is aided by the action of falling raindrops.

spore: a minute, usually spherical, haploid cell produced in the capsule as a result of meiosis; its germination gives rise to the protonema.

spore sac: a spore-containing cavity in a moss capsule.

sporocyte: a diploid cell that undergoes meiosis in the capsule to produce 4 haploid spores; sometimes called a **spore mother cell**.

sporophyte: the spore-bearing generation; initiated by the fertilization of an ovum; consists of foot, seta and capsule; attached to and partially dependent on the gametophyte.

sporopollenin: a substance in moss spore walls similar to that found in pollen grains.

spreading: of leaves inserted at 46–90° to the stem; said to be widely spreading when close to 90°.

squarrose: *of leaves*, spreading at right angles to the stem.

squarrose-recurved: spreading at right angles, with the tips curved downwards.

stance: the manner in which the leaves are held in relation to the stem.

stegocarpous: a capsule with a differentiated, dehiscent operculum.

stereid: a slender, elongate cell with very thick walls present in groups (**stereid bands**) in the costa and stem of many mosses.

stipe: the erect, unbranched basal part of a stem in a dendroid or frondose moss.

stolon: a slender, elongate branch with leaves that are often smaller and have a different shape to those of the main stem. adj. **stoloniferous**.

stoma (pl. **stomata**)**:** a pore involved in gas exchange, surround by two guard cells; in mosses restricted to the neck of the capsule.

stratose: in layers; denoting the thickness of leaves, i.e. uni-,bi- or multistratose.

stria (pl. **striae**)**:** a fine line or ridge. adj. **striate**.

striolate: very finely ridged.

struma: a cushion-like swelling at one side of the base of a capsule. adj. **strumose**.

subula: a long, slender, needle-like point; adj. **subulate**.

substratum: the surface on which a moss grows, e.g. soil, bark or rock.

sulcate: with longitudinal folds or ridges, e.g. capsules of *Ulota*.

superficial: *of stomata*, having the guard cells in the same plane as the adjacent exothecial cells.

sympodial: having a main stem of determinate growth, and further growth by innovations or lateral branches.

synoicous: having antheridia and archegonia mixed in the same gametoecium.

systylious: *of a capsule*, the operculum remains attached to the tip of the columella after the capsule has opened.

teeth: divisions of a diplolepidous exostome or outer ring of the peristome.

terete: smoothly cylindrical, round in cross-section.

tetrad: a group of four; e.g. the 4 spores derived from a single sporocyte by meiosis.

tetrahedral: a four-faced cell or spore.

theca (pl. **thecae**)**:** the spore-bearing part of a moss-capsule.

tomentum: a felt-like or woolly covering composed of abundant rhizoids on some stems, rarely on leaves. adj. **tomentose**.

trabecula (pl. **trabeculae**)**:** projecting cross-bars formed from the horizontal walls on either face of arthrodontous exostome teeth; also strands of cells bridging spaces within some capsules. adj. **trabeculate**.

transfer cells: specialised cells at the interface of the gametophyte and sporophyte which transfer nutrients from the former to the latter.

trigone: triangular intracellular wall thickenings found in the corners of three adjacent cells.

trilete spore: having a three-pronged scar on the wall (e.g. in *Sphagnum*), the scar being its area of contact with each of the three other spores in the tetrad.

triradiate ridge: a thickening on the proximal face of a spore caused by it being pressed against the three other spores of a tetrad.

truncate: cut off abruptly or squarely at the apex.

tuber: a gemma borne on rhizoids, usually underground.

tufaceous: building up deposits of calcium carbonate, e.g. around the stems of *Gemmabryum clavatum*.

tuft: a growth form with stems erect but radiating at the edges and forming small cushions.

tumid: swollen or inflated.

turf: a growth form with stems erect, parallel and close together and forming rather extensive patches.

turgid: swollen or plump.

umbellate: a frondose moss having all of its branches spreading from the apex.

umbonate: convex with an abrupt, rounded central point.

uncinate: hooked; with the tip bent to form a hook.

undulate: wavy.

urceolate: urn-shaped; used with reference to capsules that are constricted below a wide mouth, then abruptly narrowed to the seta.

urn: the spore-bearing part of the capsule.

utricle: a bladder-like structure.

vaginant: one of two clasping leaf laminae in *Fissidens* spp.; the adaxial part of the leaf that sheathes the stem and encloses the base of the leaf above it.

vaginula (pl. **vaginulae**)**:** the sheath enveloping the base of the seta, derived from the basal part of the venter of the archegonium and surrounding stem tissue and remaining after the separation of the calyptra.

venter: the swollen basal part of an archegonium, containing the ovum.

vermicular: worm-like; long narrow and curving.

verrucose: irregularly roughened. dim. **verruculose**.

verticillate: whorled.

weft: a loosely interwoven growth, often somewhat ascending.

whorled: arranged in a ring or circle.

widespreading: *of leaves*, spreading from the stem at a wide angle (less than 90°).

xerophyte: a plant that is adapted for survival in arid places. adj. **xerophytic**.

zygote: the product of the fusion of male and female gametes; the fertilized ovum before it undergoes mitosis or meiosis.

Abbreviations and Contractions

Literature

Author abbreviations follow R.K.Brummitt & C.E.Powell, *Authors of Plant Names* (Royal Botanic Gardens, Kew, 1992).

Journal titles are abbreviated in accordance with G.H.M.Lawrence *et al.*, *Botanico-Periodicum-Huntianum* (Hunt Botanical Library, Pittsburgh, 1968) and G.D.R.Bridson & E.R.Smith, *Botanico-Periodicum-Huntianum/Supplementum* (Hunt Institute for Botanical Documentation, Pittsburgh, 1991).

Other literature is abbreviated in accordance with F.A.Stafleu & R.S.Cowan, *Taxonomic Literature*, 2nd edn (Bohn, Scheltema & Holkema, Utrecht, 1976–1987), except that upper case initial letters are used for proper names and significant words. The *Flora of Australia* is abbreviated to *Fl. Australia*.

Herbaria

Abbreviations of herbaria are in accordance with P.K.Holmgren, N.H.Holmgren & L.C.Barnett, *Index Herbariorum* Part I, 8th edn (New York Botanical Garden, 1990). Those most commonly cited in the *Flora* are:

AD	State Herbarium of South Australia, Adelaide
BM	The Natural History Museum, London
BRI	Queensland Herbarium, Brisbane
CANB	Australian National Herbarium, Canberra
DNA	Northern Territory Herbarium, Darwin
HO	Tasmanian Herbarium, Hobart
K	Royal Botanic Gardens, Kew
MEL	National Herbarium of Victoria, Melbourne
NSW	National Herbarium of New South Wales, Sydney
PERTH	Western Australian Herbarium, Perth
QRS	Australian National Herbarium, Atherton

States, Territories

Abbreviations of Australian States and Territories as used in statements of distribution and citation of collections are:

A.C.T.	Australian Capital Territory
N.S.W.	New South Wales
N.T.	Northern Territory
Qld	Queensland
S.A.	South Australia
Tas.	Tasmania
Vic.	Victoria
W.A.	Western Australia

General abbreviations

add.	addendum
agg.	aggregate species
alt.	altitude
app.	appendix
auct.	*auctoris/auctorum* (of an author or authors)
auct. mult.	*auctorum multorum* (of many authors)
auct. non	*auctorum non* (of authors [but] not....), used for misapplied names
c.	*circa* (about)
cf.	*confer* (compare)
Ck	Creek
cm	centimetre
coll.	collector
colln	collection
comb.	*combinatio*/combination
cons.	*conservandus*
cult.	cultivated
cv.	cultivar
d.b.h.	diameter at breast height
Dept	Department
descr.	*descriptio*
diam.	diameter
E	east
ed./eds	editor/editors
edn	edition
e.g.	*exempli gratia* (for example)
et al.	*et alii*/*et aliorum*; and others/and of others
f.	*forma/*form
fam.	*familia/*family
fig./figs	figure/figures (in other works)
Fig.	Figure (referring to a Figure in this volume of the *Flora*)
gen.	*genus/*genus
gen. nov.	*genus novus* (new genus)
Gt	Great
holo	holotype
hort.	*hortus* (garden) or *hortensis* (of a garden)
HS	Homestead
Hwy	Highway
i.e.	*id est* (that is)
ined.	*ineditus* (unpublished)
in litt.	*in litteris* (in correspondence)
in obs.	*in observatio* (in observation)
IPL	inner peristomial layer
Is.	Island/s
iso	isotype
isolecto	isolectotype
km	kilometre
L.	Lake
L.A.	Logging Area
lat.	latitude
lecto	lectotype
loc. cit.	*loco citato* (in bibliographic citations: in the same work and page as just cited)
loc. id.	*loco idem* (in specimen citations: in the same place as just cited)
long.	longitude

L.S.	longitudinal section
m	metre
m	the smallest chromosome
Ma	million years ago
mm	millimetre
Mt/Mts	Mount/Mounts
Mtn/Mtns	Mountain/Mountains
N	north
n	haploid chromosome number
2n	diploid chromosome number
Natl	National
NE	north-east (ern)
neo	neotype
nom. cons.	*nomen conservandum* (conserved name)
nom. cons. prop.	*nomen conservandum propositus* (proposed conserved name)
nom. illeg.	*nomen illegitimum* (illegitimate name)
nom. inval.	*nomen invalidum* (name not validly published)
nom. nov.	*nomina nova* (new name)
nom. nud.	*nomen nudum* (name published without a description or reference to a published description)
nom. prov.	*nomen provisorium* (provisional name)
nom. rej.	*nomen rejiciendum* (rejected name)
nom. superfl.	*nomen superfluum* (superfluous name)
nov.	*novus/*new
n. ser.	new series
n.v.	*non vidi* (not seen)
NW	north-west (ern)
op. cit.	*opere citato* (in the work cited above)
OPL	outer peristomial layer
opp.	opposite
ordo	order
orth.	orthography, orthographic
p./pp.	page/pages
para	paratype
penin.	peninsula
pers. comm.	by personal communication
pl./pls	plate/plates
p.p.	*pro parte* (in part)
PPL	primary peristomial layer
p.p. max	*pro parte maxima*, the larger part
p.p. min	*pro parte minore*, the smaller part
Pt	Point
q.v.	*quod vide* (which see)
R.	River
Ra.	Range/Ranges
Rd	Road
rly	railway
S	south
SE	south-east (ern)
sect.	*sectio/*section
SEM	Scanning Electron Micrograph
ser.	series
S.F.R.	State Forest Reserve
sic	thus

s. lat.	*sensu lato* (in a wide sense)
s. loc.	*sine loco* (without locality)
s.n.	*sine numero* (without number)
sp./spp.	species (singular/plural)
sp. aff.	*species affinis* (species related to)
sp. nov.	*species nova* (new species)
s. str.	*sensu stricto* (in a narrow sense)
St.	Saint/Street
stat.	*status/*status
Stn	(pastoral) Station
subg.	subgenus
subsp./subspp.	subspecies (singular/plural)
subsp. nov.	*subspecies nova* (new subspecies)
suppl.	supplement
SW	south-west (ern)
syn	syntype
synon.	synonym
T	Type (collection)
t./tt.	*tabula/tabulae* (plate/plates)
T.R.	Timber Reserve
trib.	*tribus/*tribe
trig.	trigonometric station
T.S.	transverse section
typ. cons.	*typus conservandus* (conserved type)
var.	*varietas/*variety
viz.	*videlicet* (namely)
W	west
x	basic chromosome number

Symbols

±	*in species descriptions*, more or less
<	less than
>	more than
µm	micrometre

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SYSTEMATIC ARRANGEMENT OF AUSTRALIAN MOSSES

Classification largely follows B.Goffinet & W.R.Buck, Systematics of the Bryophyta (mosses): from molecules to a revised classification, *Monogr. Syst. Bot.* 98: 205–239 (2004).

Class Sphagnopsida
Order Sphagnales
Family Sphagnaceae: *Sphagnum*
Order Ambuchananiales
Family Ambuchananiaceae: *Ambuchanania*

Class Andreaeopsida
Order Andreaeales
Family Andreaeaceae: *Andreaea*

Class Polytrichopsida
Order Polytrichales
Family Polytrichaceae: *Atrichum*, *Dawsonia*, *Notoligotrichum*, *Pogonatum*, *Polytrichadelphus*, *Polytrichastrum*, *Polytrichum*

Class Bryopsida
Subclass Buxbaumiidae
Order Buxbaumiales
Family Buxbaumiaceae: *Buxbaumia*

Subclass Diphysciidae
Order Diphysciales
Family Diphysciaceae: *Diphyscium*

Subclass Funariidae
Order Encalyptales
Family Encalyptaceae: *Encalypta*, *Bryobartramia*

Order Funariales
Family Funariaceae: *Entosthodon*, *Funaria*, *Physcomitrella*, *Physcomitrium*
Family Gigaspermaceae: *Gigaspermum*

Subclass Dicranidae
Order Scouleriales
Family Scouleriaceae: *Tridontium*

Order Grimmiales
Family Grimmiaceae: *Grimmia*, *Racomitrium*, *Schistidium*
Family Seligeriaceae: *Blindia*, *Brachydontium*, *Seligeria*
Family Ptychomitriaceae: *Ptychomitrium*

Order Archidiales
Family Archidiaceae: *Archidium*

Order Dicranales
Family Fissidentaceae: *Fissidens*, *Nanobryum*
Family Dicranaceae: *Campylopodium*, *Dicnemon*, *Dicranoloma*, *Dicranella*, *Dicranum*, *Eucamptodon*, *Holomitrium*, *Leptotrichella*, *Leucoloma*, *Sclerodontium*
Family Leucobryaceae: *Campylopus*, *Leucobryum*
Family Calymperaceae: *Arthrocormus*, *Calymperes*, *Exostratum*, *Leucophanes*, *Mitthyridium*, *Octoblepharum*, *Syrrhopodon*
Family Ditrichaceae: *Ceratodon*, *Chrysoblastella*, *Distichium*, *Ditrichum*, *Eccremidium*, *Garckea*, *Pleuridium*, *Wilsoniella*
Family Bruchiaceae: *Bruchia*, *Trematodon*
Family Rhabdoweisiaceae: *Amphidium*, *Dicranoweisia*, *Kiaeria*, *Verrucidens*
Family Erpodiaceae: *Erpodium*
Family Mitteniaceae: *Mittenia*
Family Viridivelleraceae: *Viridivellus*

Order Pottiales
Family Pottiaceae: *Acaulon*, *Aloinia*, *Anoectangium*, *Barbula*, *Bryoerythrophyllum*, *Calymperastrum*, *Calyptopogon*, *Chenia*, *Crossidium*, *Didymodon*, *Goniomitrium*, *Gymnostomum*, *Hennediella*, *Hymenostomum*, *Hyophila*, *Leptodontium*, *Microbryum*, *Phascopsis*, *Phascum*, *Pottia*, *Pseudosymblepharis*, *Pterygoneurum*, *Stonea*, *Tetrapterum*, *Tortella*, *Tortula*, *Trachycarpidium*, *Trichostomum*, *Triquetrella*, *Uleobryum*, *Weissia*
Family Pleurophascaceae: *Pleurophascum*
Family Splachnobryaceae: *Gymnostomiella*, *Splachnobryum*
Family Ephemeraceae: *Ephemerum*, *Nanomitriopsis*

Subclass Bryidae
Order Splachnales
Family Splachnaceae: *Tayloria*
Family Meesiaceae: *Leptobryum*, *Meesia*

Order Orthotrichales
Family Orthotrichaceae: *Groutiella*, *Macrocoma*, *Macromitrium*, *Orthotrichum*, *Schlotheimia*, *Stoneobryum*, *Ulota*, *Zygodon*

Order Hedwigiales

Family Hedwigiaceae: *Hedwigia*, *Hedwigidium*
Family Rhacocarpaceae: *Rhacocarpus*

Order Bryales

Family Aulacomniaceae: *Aulacomnium*
Family Bartramiaceae: *Bartramia*, *Breutelia*, *Conostomum*, *Philonotis*
Family Orthodontiaceae: *Orthodontium*
Family Bryaceae: *Brachymenium*, *Bryum*, *Gemmabryum*, *Ochiobryum*, *Plagiobryum*, *Ptychostomum*, *Rhodobryum*, *Rosulabryum*
Family Mniaceae: *Mielichhoferia*, *Orthomnion*, *Plagiomnium*, *Pohlia*, *Schizymenium*
Family *Leptostomaceae: Leptostomum*

Order Rhizogoniales

Family Hypnodendraceae: *Hypnodendron*
Family Rhizogoniaceae: *Goniobryum*, *Hymenodon*, *Leptotheca*, *Mesochaete*, *Pyrrhobryum*, *Rhizogonium*
Family Calomniaceae: *Calomnion*
Family Cyrtopodaceae: *Bescherellia*
Family Spiridentaceae: *Spiridens*
Family Pterobryellaceae: *Pterobryella*
Family Racopilaceae: *Powellia*, *Racopilum*

Order Ptychomniales

Family Ptychomniaceae: *Euptychium*, *Garovaglia*, *Glyphothecium*, *Hampeella*, *Ptychomnion*, *Tetraphidopsis*

Order Hookeriales

Family Hypopterygiaceae: *Cyathophorum*, *Hypopterygium*, *Lopidium*
Family Saulomataceae: *Sauloma*
Family Daltoniaceae: *Achrophyllum*, *Bryobrothera*, *Calyptrochaeta*, *Daltonia*, *Distichophyllum*, *Ephemeropsis*
Family Leucomiaceae: *Leucomium*
Family Pilotrichaceae: *Callicostella*, *Cyclodictyon*, *Hookeriopsis*

Order Hypnales

Family Trachylomataceae: *Braithwaitea*, *Trachyloma*
Family Climaciaceae: *Climacium*
Family Amblystegiaceae: *Amblystegium*, *Anacamptodon*, *Bryostreimannia*, *Campylium*, *Cratoneuropsis*, *Drepanocladus*, *Leptodictyum*, *Orthotheciella*, *Sanionia*
Family Calliergonaceae: *Scorpidium*, *Straminergon*, *Warnstorfia*
Family Hylocomiaceae: *Rhytidiadelphus*
Family Leskeaceae: *Claopodium*, *Pseudoleskeopsis*
Family Catagoniaceae: *Catagonium*
Family Pterigynandraceae: *Trachyphyllum*
Family Thuidiaceae: *Pelekium*, *Thuidiopsis*, *Thuidium*
Family Brachytheciaceae: *Brachythecium*, *Eurhynchium*, *Helicodontium*, *Platyhypnidium*, *Pseudoscleropodium*, *Rhynchostegium*, *Scleropodium*, *Scorpiurium*
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Family Myriniaceae: *Macgregorella*
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Family Sematophyllaceae: *Acanthorrhynchium*, *Acroporium*, *Macrohymenium*, *Meiotheciella*, *Meiothecium*, *Papillidiopsis*, *Pseudohypnella*, *Radulina*, *Rhaphidorrhynchium*, *Sematophyllum*, *Trichosteleum*, *Warburgiella*
Family Myuriaceae: *Myurium*, *Oedicladium*
Family Cryphaeaceae: *Cryphaea*, *Cyptodon*, *Dendrocryphaea*, *Schoenobryum*
Family Pterobryaceae: *Calyptothecium*, *Cryptogonium*, *Muellerobryum*, *Neolindbergia*, *Pterobryidium*, *Pterobryon*, *Pulchrinodus*, *Rhabdodontium*
Family Orthorrhynchiaceae: *Orthorrhynchium*
Family Lepyrodontaceae: *Lepyrodon*
Family Neckeraceae: *Caduciella*, *Himantocladium*, *Homaliodendron*, *Neckera*, *Neckeropsis*, *Pinnatella*, *Thamnobryum*, *Touwia*
Family Echinodiaceae: *Echinodium*
Family Leptodontaceae: *Forsstroemia*, *Leptodon*
Family Lembophyllaceae: *Acrocladium*, *Camptochaete*, *Fallaciella*, *Lembophyllum*, *Weymouthia*
Family Anomodontaceae: *Anomodon*, *Herpetineuron*
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